ELECTRONICS &
Wireless world

July 1984 85p

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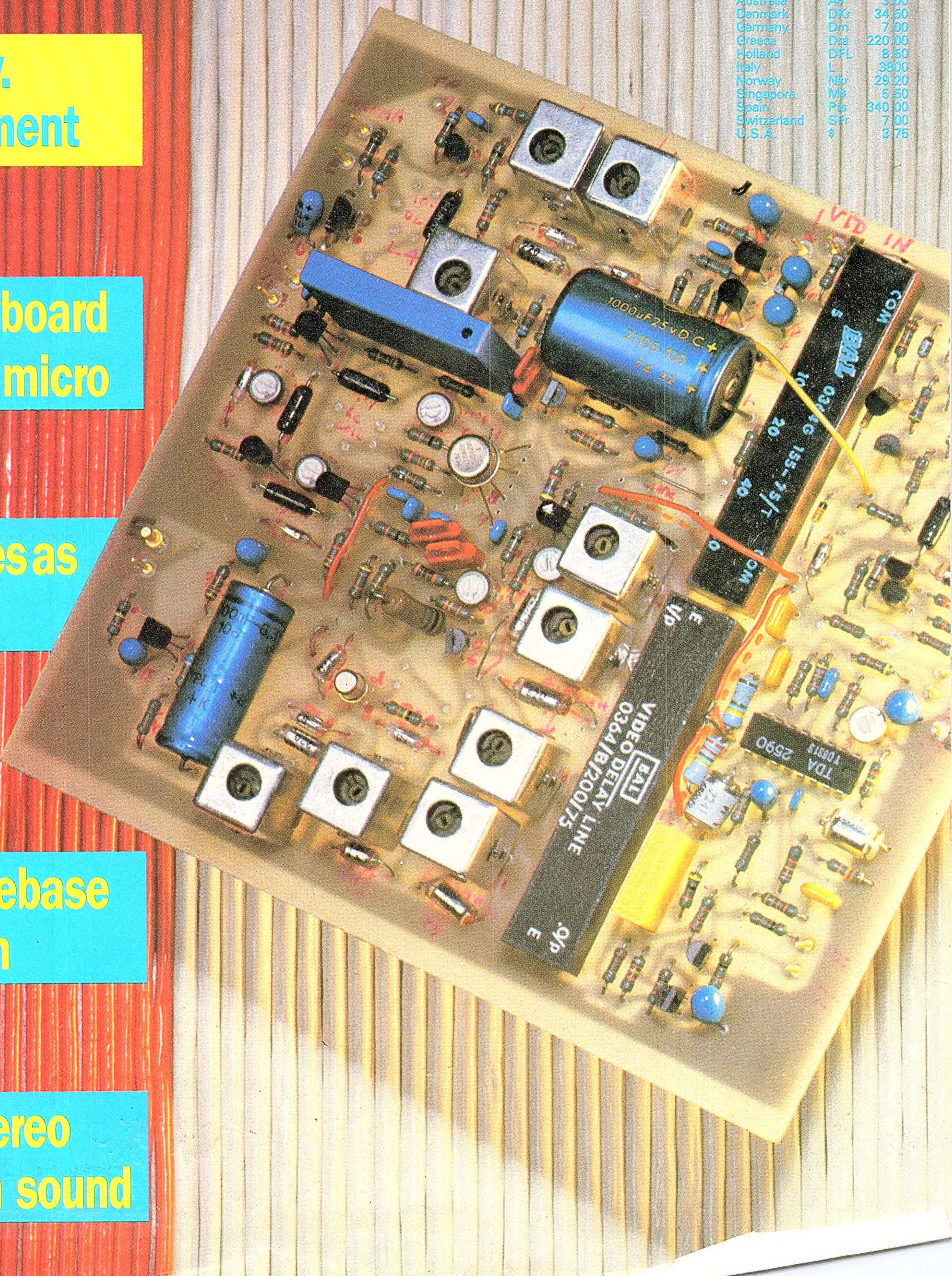
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BAL 0364/B/200/75
VIDEO DELAY LINE
TDA 2590
I/P
O/P

GP Programming Systems from Stock

EP8000
EPROM ERASER UV141
P8000
rEAdy
GP P8000 EPROM PROGRAMMER
GP PROM PROGRAMMING ADAPTOR

EP8000 and EP4000 EPROM Emulator/Programmers

- ☐ Software personality programming of NMOS, HMOS, CMOS EPROMs, both single & triple rail up to 16k x 8 bytes (EP8000).
- ☐ Expandable to program PROMs with BP5 Signetics PROM adaptor.
- ☐ Emulation of all EPROMs up to 8k x 8 bytes with the EP8000 and up to 4k x 8 bytes with the EP4000.
- ☐ No personality cards or characterisers required.
- ☐ Use as stand alone programmer, slave programmer, or EPROM development system.
- ☐ Checks for misplaced, reversed insertion and shorts on data lines (EP8000).
- ☐ Memory mapped video O/P, in addition to LED display allows full use of powerful editing facilities, including block/Byte move, insert, delete, match, highlight, shift, define, displacement calculation.
- ☐ Comprehensive I/O — RS232 serial port, parallel port.
- ☐ Ex-stock EP8000 — 8k x 8 RAM £695 + £12 del + VAT EP4000 — 4k x 8 RAM £545 + £12 del + VAT.

P8000 Production EPROM Programmer

- ☐ Programs NMOS, HMOS, CMOS EPROMs up to 16k x 8 bytes, both single & triple rail.
- ☐ No personality cards or characterisers required.
- ☐ Up to 8 EPROMs programmed simultaneously.
- ☐ Simple menu driven operation.
- ☐ Reverse and misplaced insertion checks. Constant power supply monitoring and system checks.
- ☐ Checksum, illegal bit test, blank check, compare and self check cycles.
- ☐ RS232 serial interface as standard.
- ☐ Single key programming operation.
- ☐ Ex-stock P8000 — £695 + £12 del + VAT.

Accessories for the EP8000 and EP4000 range

NEW

- ☐ BP5 Bipolar PROM Programming Module.
- ☐ Allows the EP8000 and EP4000 to program, copy, verify a range of 21 Signetics bipolar PROMs up to 2k x 8 bytes sizes Ex-stock — £228 + VAT.
- ☐ SA27128 Adaptor. Allows EP8000 to program 27128 EPROM Ex-stock — £69 + VAT.
- ☐ UV141 EPROM Eraser. Erases up to 14 devices simultaneously — safety interlocked — electronic timer. Ex-stock — £78 + VAT.
- ☐ Prinz Video Monitor. Green phosphor, high resolution video monitor suitable for EP8000 and EP4000 Ex-stock — £99 + VAT.
- ☐ Contact us now for a complete product data pack.

GP Industrial Electronics Ltd

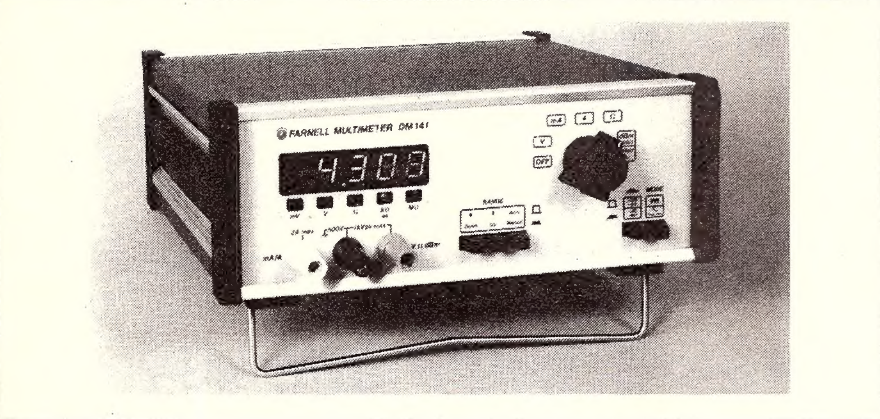
Tel: Plymouth (0752) 332961
Telex: 42513

Unit E, Huxley Close, Newnham Ind. Estate, Plymouth PL7 4JN

CIRCLE 001 FOR FURTHER INFORMATION

JOHN G. HOLLOW

4½ DIGIT AUTORANGING MULTIMETER – THE DM141



- 10µV, 4½ digits, 28500 counts
- True r.m.s. up to 20kHz
- Autoranging or manual range selection
- Big, bright, high efficiency LED display
- +30 to −60dBm function
- Up to 2.5kV spike protection
- Diode test facility
- B.C.D. version available. IEEE488 compatible with Omnibus OB1 option
- British design and manufacture by Farnell

This 4½ digit autoranging digital multimeter measures a.c. and d.c. volts and current, resistance and dBm. A.C. measurements and dBm are true r.m.s. with a frequency response of 45Hz to 20kHz.

For automatic ranging select the required function, connect and read. The DM141 will automatically select the best range and position the decimal point.

Manual range changes can be achieved using the UP or DOWN range push buttons and the HOLD facility is sometimes useful to stop automatic range changes around the 19999 count. The manual facility may be used to increase resolution as the DM141 provides up to 28500 counts on overrange.

Resolution on volts is 10µV and on current 1µA. Resistance measurements down to 10mΩ are possible. The dynamic range of the decibel function is +30 to −60. Overload protection is excellent and includes spike protection to 2.5kV. Basic d.c. accuracy is 0.03%.

The displays are seven segment 0.43" red LEDs of the high efficiency type with range and decimal point being automatically annunciated. An autozero facility is provided and autopolarity means no lead switching and positive or negative reading clearly indicated. The sampling rate is 3 readings per second. An overrange condition is indicated by all displays flashing.

DETAILS FROM:

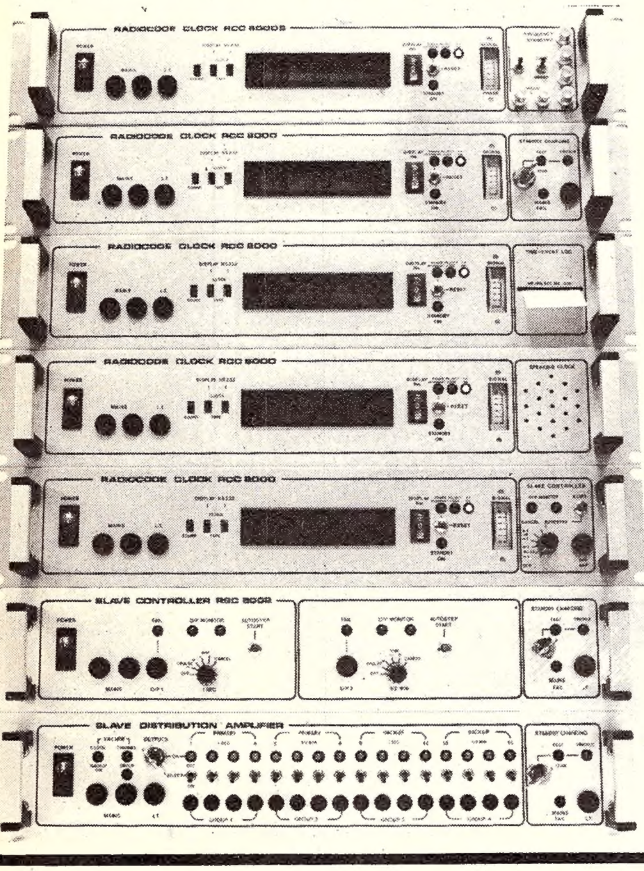
Farnell

**FARNELL INSTRUMENTS LIMITED
SANDBECK WAY · WETHERBY
WEST YORKSHIRE LS22 4DH
TELEPHONE (0937) 61961
TELEX 557294 FARIST G**

CIRCLE 5 FOR FURTHER DETAILS.

RADIOCODE CLOCKS SOLVE PROBLEMS

ATOMIC TIME, FREQUENCY AND SYNCHRONISATION EQUIPMENT


RADIOCODE CLOCK RCC 8000S
RADIOCODE CLOCK RCC 8000
SLAVE CONTROLLER RSC 8001
SLAVE DISTRIBUTION AMPLIFIER

NEW PHASE-MODULATION SYSTEMS

Until recently, atomic time and date information was only available on v.l.f. transmissions using amplitude modulation. The RCC 8000AM series of equipment uses these transmissions to offer high noise immunity and high accuracy, particularly at very long range.

The new RCC 8000PM series of equipment uses, for the first time, phase modulated tranmissions with massive radiated powers of up to 2 Mega-Watts to offer long range, excellent noise immunity and no scheduled maintenance periods.

NEW PRODUCTS

The AM and PM series of Radiocode Clock equipment has been further expanded to include seven new models (from top) **8000S** – combined clock, frequency standard and optional stopclock. **Internal standby power supply** – with dual rate constant current charger. **Time-event log** – prints hours, minutes, seconds, milliseconds and day of year, on receipt of a log pulse. **Speaking clock** – time announcement or audio recording. **Slave controller** – total control of single-standard master/slave systems ie one pulse/sec. **Dual standard slave controller** – total control of two different and independent slave systems, ie. one pulse/sec and one pulse/half min. **Slave distribution amplifier** – maximum flexibility for the largest master/slave installations requiring dual standard operation, multiple circuits and complete master/slave backup.

NEW OPTIONS

A continuously expanding range of fully integrated software and hardware is available for both series of Radiocode Clock equipment. Standard options now include:

- IRIG B precision serial o/p
- RS232/V24 1mS resolution
- General purpose parallel o/p
- FSK record/replay system
- Keypad entry of alarm times
- Keypad entry of time/date
- Time code generators
- Intelligent slave systems
- Standard frequency outputs
- Stopclock operation
- Calibrated systems for increased accuracy

Radiocode Clocks Ltd*
Unit 19, Parkengue, Kernick Road Industrial Estate
Penryn, Falmouth, Cornwall. Tel: Falmouth (0326) 76007
(*A Circuit Services Associate Co.)

CIRCLE 45 FOR FURTHER DETAILS.

ELECTRONICS &
Wireless world

over 70 years in independent electronics publishin

July 1984 Volume 90 number 15

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This issue has been affected by the continuing dispute between members of the National Union of Journalists and Reed International. We apologise to readers and advertisers for its late appearance. The next issue of Electronics and Wireless World, cover dated August/September should be published on 15 August.

INTERFACING

by R. M. Adelson

Music keys for the BBC microcomputer

Using the computer's sound unit or external generators, this economical polyphonic keyboard interface makes a musical instrument and an educational tool for storage, analysis and display of music.

TREE TV

Television reception with papaya tree antenna

by S.P. Kosta
K.N. Shamanna
R. Bhawani Shanker
K.S. Dayashankara
B. Rudralingappa
V.R. Katti
Y.P. Kosta

Novel technique couples r.f. energy from vegetation canopy to receive tv signals.

VARIABLE-SPEED VIDEO

Variable-speed video playback

by J. R. Watkinson, M.Sc., B.Sc.

Using C-format video recorders over a wide speed range. Discussion continues with a description of the effect of the recording process on video waveforms.

Front cover pictures David Read's PAL colour tv enhancement board, also pictured on page 37, comprising PAL modifier and comb filter decoder.

NEXT MONTH

Laboratory equipment for measurement in linear motion includes a computer-to-air interface. Detection of rider position enables RML computer to carry out experiments and display results.

In Stage Lighting System, forty 1 kilowatt circuits are remotely controlled with one cable linking desk and dimmers. A Z80 multiplexes data from the controls.

Dr Ken Smith of Kent University contributes a short series on power supply design, concentrating on the switched-mode variety. And John Adam's SC84 switch-regulated power supply is suitable for any application requiring an efficient, simple and economical power unit with either fixed or variable output. John also gives some SC84 construction tips.

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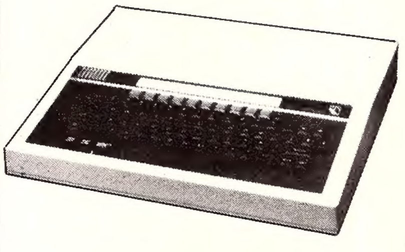

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NEW TORCH Z80 PACK PRICE £699.
SOFTWARE PACKAGE INCLUDES Z80 BASIC

Phone for details about the 20Mbyte Hard Disc Pack, and the 68000 Hard Disc Pack with UNIX Operating System.

NOW AVAILABLE — The TORCH Z80 SECOND PROCESSOR CARD — for those who already have suitable disc drives. The card is supplied with all th free perfect software and Z80 basic, as detailed above, presenting a very attractive package. £299.
Torch ZH0 240 Mbyte Hard Disc + 400K Flopy. £1995 (a)

ACORN IEEE INTERFACE

A full implementation of the IEEE-488 standard, providing computer control of compatible scientific & technical equipment, at a lower price than other systems. Typical applications are in experimental work in academic and industrial laboratories. The interface can support a network of up to 14 other compatible devices, and would typically link several items of test equipment allowing them to run with the optimum of efficiency. The IEEE Filing System ROM is supplied. **£282.**

BUZZ BOX A full spec pocket size direct connect modem with both Originate and Answer modes. this BT approved modem conforms to CCITT V21 300/300 Baud Standard. Battery/Mains powered plugs directly into telephone line. Modem Z69 head Z3:50 Ext PSU Z8:00

BOOKS

We have a large selection of books on the BBC and other titles. Please ask for details. No VAT on books.

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A low cost unit that opens up the total range of Real-Time applications. With its full battery backup, possibilities include an Electronic Diary, continuous display of 'on-screen' time and date information automatic document dating, precise timing & control in scientific applications, recreational use in games etc — its uses are endless and are simply limited by one's imagination. Simply plugs into the user port — no specialist installation required — No ROMS. Supplied with extensive applications software. **Please phone for details. £29.00 + £2.50 carriage.**

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EPSON FX-100	£480.00a
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ACCESSORIES

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Computer Grade Cassette 10 off	£4.00c
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SOFTY II

This low cast intelligent eprom programmer can program 2716, 2516, 2532, 2732, and with an adaptor, 2564 and 2764. Displays 512 byte page on TV — has a serial and parallel I/O routines. Can be used as an emulator, cassette interface. Softy II £169 (b) Adaptor for 2764/2564 £25.00 (c).

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The original 'infinite speech'. Still the best.

A ready built totally self contained speech synthesiser unit, attractively packaged with built-in speaker, AUX output socket etc. — no installation problems! It allows the creation of any English word, with both ease and simplicity, while, at the same time being very economical in memory usage. You can easily add speech to most existing programs. Due to its remarkable infinite vocabulary, its uses spread throughout the whole spectrum of computer applications — these include industrial, commercial, educational, scientific, recreational etc. No specialist installation — no need to open your computer, simply plugs into the user port — and due to the simple software, no ROMS are needed. SMARTMOUTH is supplied with demo and development programs on cassette, and full software instruction. **£37 + £2.50 carriage.**

UV ERASERS

UV1T Eraser with built-in timer and mains indicator. Built-in safety interlock to avoid accidental exposure to the harmful UV rays. It can handle up to 5 eproms at a time with an average erasing time of about 20 mins. **£59 + £2 p&p.** UV1 as above but without the timer. **£47 + £2 p&p.** For Industrial Users, we offer UV140 & UV141 erasers with handling capacity of 14 eproms. UV141 has a built-in timer. Both offer full built-in safety features UV140 **£61,** UV141 **£79, p&p £2.50.**

PRODUCTION PROGRAMMER:

P8000

P8000 provides reliable gang programming of up to 8 EPROMS simultaneously with device sizes up to 16K × 8 bytes. Devices supported range from 2704 to 27128 in single and three rail versions. Simple menu driven operation ensure easy eprom selection and reliable programming in minimum programming times. **£695 + £6 carriage.**

EP 8000

This CPU controlled Emulator Programmer is a powerful tool for both Eprom programming and development work. EP 8000 can emulate and program all eproms up to 8K × 8 bytes, can be used as stand-alone unit for editing and duplicating EPROMS, as a slave programmer or as an eprom emulator **£695 (a).**

BBC EPROM PROGRAMMER:

A fully self-contained mains-powered eprom programmer housed in an attractive finished case. It is able to program 2716, 2732/32A, 2764 & 27128's in a single pass. It is supplied with vastly superior software than available to any currently available similar programmer. In addition to normal eprom programming, you are now able to load your favourite basic programs onto eprom.

*** Menu Driven Software provides user friendly options for programming the eprom with:**
a) Basic programs
b) Ram resident programs.
c) Any other program.

***Programmer can read, blank-check, program & verify at any address/addresses on the Eprom.**
*** Personality selection is simplified by a single rotary switch.**
*** Programming voltage selector switch.**
*** Full Editor with ASCII Disassembler, allowing direct modification data in HEX or ASCII.**
*** Continuous display of time left for completion of programming.**
*** Continuous display of current addresses as they are being programmed.**

The programmer comes complete with cables, software & operating manual.
£89 + £2.50 carriage. Software on disc £2 extra.

CONNECTOR SYSTEMS

I.D. CONNECTORS

(Speedblock Type)

No of ways	Header Plug	Receptacle	Edge Conn.
10	**90p**	**85p**	**120p**
20	**145p**	**125p**	**195p**
26	**175p**	**150p**	**240p**
34	**200p**	**160p**	**320p**
40	**220p**	**190p**	**340p**
50	**235p**	**200p**	**390p**

D CONNECTORS

	No. of ways 9	15	25	37
MALE				
Solder	**80p**	**105p**	**160p**	**250p**
Angled	**150p**	**210p**	**250p**	**365p**
FEMALE				
Solder	**105p**	**160p**	**200p**	**335p**
Angled	**165p**	**215p**	**290p**	**440p**
Hoods	**90p**	**85p**	**90p**	**100p**

IDC 15-way plug **340p.** Socket **400p**
IDC 25-way plug **385p.** Socket **450p**

TEXTOOL ZIF

SOCKETS 24-pin **£5.75**
28-pin **£8.00** 40-pin **£9.75**

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4-way **70p** 8-way **130p**
6-way **100p** 10-way **150p**

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24″ Ribbon Cable with Headers

	14-pin	16-pin	24-pin	40-pin
1 end	**145p**	**165p**	**240p**	**350p**
2 ends	**210p**	**230p**	**345p**	**540p**

24″ Ribbon Cable with Sockets

	20-pin	26-pin	34-pin	40-pin
1 end	**160p**	**200p**	**280p**	**300p**
2 ends	**290p**	**370p**	**480p**	**525p**

Ribbon Cable with D. Conn.
25-way Male **500p** Female **550p**

RS 232 JUMPERS

(25-way D)

24″ Single end Male	**£5.00**
24″ Single end Female	**£5.25**
24″ Female-Female	**£10.00**
24″ Male-Male	**£9.50**
24″ Male-Female	**£9.50**

DIL HEADERS

	Solder Type	IDC Type
14pin	**40p**	**100p**
16pin	**50p**	**110p**
24pin	**100p**	**150p**
28pin	**200p**	**225p**
40pin	**200p**	—

AMPHENOL CONNECTORS

	Solder	IDC
36-way plug Centronics	**£5.25**	**£5.25**
36-way socket Centronics	**£5.50**	**£5.50**
24-way plug IEEE	**£5.00**	**£4.75**
24-way socket IEEE	**£5.00**	**£4.75**

PCB Mtg Skt Ang pin
24-way **£6.00.** 36-way **£6.50**

RIBBON CABLE

(Grey/meter)

10-way	**40p**
16-way	**60p**
20-way	**85p**
26-way	**120p**
34-way	**160p**
40-way	**180p**
50-way	**200p**
64-way	**280p**

EURO CONNECTORS

	Plug	Skt.
DIN 41617		
21-way	**160p**	**165p**
31-way	**170p**	**170p**
DIN 41612		
2×32-way St. Pin	**230p**	**275p**
2×32-way Ang. Pin	**275p**	**320p**
3×32-way St. Pin	**260p**	**300p**
3×32-way Ang. Pin	**375p**	**400p**

1 DC Skt A + B **275p** A + C **350p**
For 2 x 32-way please specify spacing (A + B, A + C)

TEST CLIPS

14-pin **375p** 16-pin **400p**
40-pin **£10.30**

EDGE CONNECTORS

	0.1″	0.156″
2x6-way (Commodore)	–	**300p**
2x10-way (Commodore)	**150**	–
2×12-way (Vic 20)	–	**350p**
2×18-way	–	**140p**
2×23-way (ZX81)	**175p**	**220p**
2×25-way	**225p**	**220p**
2×28-way (Spectrum)	**200p**	–
2x36-way	**250p**	–
1×43-way	**260p**	–
2x22-way	**190p**	–
2×43-way	**395p**	
1×77-way	**400p**	**500p**
2x50-way (S100conn)	**600p**	–

74 SERIES

7400	POA100p
7401	60p
7402	100p
7403	60p
7404	POA100p
7405	60p
7406	POAp
7407	POAp
7408	100p
7409	60p
7410	100p
7411	60p
7412	50p
7413	75p
7414	90p
7416	POA200p
7417	POA200p
7420	60p
7421	100p
7422	60p
7423	60p
7425	75p
7426	60p
7427	60p
7428	60p
7430	60p
7432	POAp
7433	60p
7437	60p
7438	100p
7439	50p
7440	60p
7441	120p
7442A	75p
7444	120p
7445	160p
7446A	120p
7447A	120p
7448	120p
7450	60p
7451	60p
7453	60p
7454	60p
7460	75p
7470	75p
7472	75p
7473	75p
7474	100p
7475	100p
7476	80p
7480	80p
7481	220p
7483A	120p
7484A	250p
7485	120p
7486	70p
7489	300p
7490A	75p
7491	70p
7492A	90p
7493A	75p
7494	150p
7495A	90p
7496	100p
7497	250p
74100	220p
74107	75p
74109	75p
74110	90p
74111	55p
74116	220p
74118	200p
74119	300p
74120	180p
74121	90p
74122	100p
74123	150p
74125	100p
74126	100p
74128	120p
74132	100p
74136	90p
74141	180p
74142	450p
74143	480p
74144	480p
74145	140p
74147	225p
74148	180p
74150	225p
74151A	100p
74153	100p
74154	250p
74155	100p
74156	110p
74157	110p
74159	320p
74160	120p
74161	75p
74162	90p
74163	90p
74164	90p
74165	100p
74166	120p
74167	400p
74170	250p
74172	750p
74173	180p
74174	120p
74175	120p
74176	150p
74177	150p
74178	250p
74179	250p
74180	150p
74181	380p
74182	200p
74184	300p
74185A	300p
74190	140p
74191	140p
74192	140p
74193	140p
74194	140p
74195	100p
74196	140p
74197	140p
74198	250p
74199	250p
74221	150p
74251	150p
74259	250p
74265	100p
74273	270p
74276	350p
74278	370p
74279	150p
74283	170p
74285	350p
74290	140p
74293	140p
74298	225p
74351	225p
74365A	100p
74366A	100p
74367A	100p
74368A	100p
74376	200p
74390	225p
74393	225p
74490	300p

74LS SERIES

74LS00	POA100p
74LS01	60p
74LS02	POA100p
74LS03	60p
74LS04	POA100p
74LS05	70p
74LS08	100p
74LS09	60p
74LS10	100p
74LS11	70p
74LS12	60p
74LS13	75p
74LS14	120p
74LS15	60p
74LS20	60p
74LS21	60p
74LS22	70p
74LS26	70p
74LS27	70p
74LS28	70p
74LS30	60p
74LS32	POA100p
74LS33	60p
74LS37	60p
74LS38	100p
74LS40	60p
74LS42	100p
74LS47	140p
74LS48	140p
74LS51	60p
74LS54	60p
74LS55	60p
74LS73A	75p
74LS74A	100p
74LS75	90p
74LS76A	75p
74LS83A	120p
74LS85	150p
74LS86	75p
74LS90	90p
74LS91	110p
74LS92	100p
74LS93	90p
74LS95B	100p
74LS96	160p
74LS107	75p
74LS109	75p
74LS112	90p
74LS113	75p
74LS114	75p
74LS122	100p
74LS123	200p
74LS124/629	300p
74LS125	90p
74LS126	90p
74LS132	90p
74LS133	90p
74LS136	75p
74LS138	120p
74LS139	120p
74LS145	150p
74LS147	220p
74LS148	220p
74LS151	100p
74LS153	100p
74LS154	300p
74LS155	140p
74LS156	125p
74LS157	100p
74LS158	100p
74LS160A	140p
74LS161A	140p
74LS162A	140p
74LS163A	140p
74LS164	140p
74LS165A	160p
74LS166A	250p
74LS168	200p
74LS169	200p
74LS170	220p
74LS173A	120p
74LS174	120p
74LS175	120p
74LS181	250p
74LS183	270p
74LS190	130p
74LS191	130p
74LS192	130p
74LS193	130p
74LS194A	130p
74LS195A	130p
74LS196	130p
74LS197	130p
74LS221	140p
74LS240	250p
74LS241	250p
74LS242	140p
74LS243	140p
74LS244	300p
74LS245	350p
74LS247	120p
74LS248	120p
74LS249	120p
74LS251	100p
74LS253	100p
74LS256	200p
74LS257A	120p
74LS258A	100p
74LS259	200p
74LS260	90p
74LS261	120p
74LS266	100p
74LS273	240p
74LS275	175p
74LS279	120p
74LS280	240p
74LS283	120p
74LS290	110p
74LS292	900p
74LS293	120p
74LS295	140p
74LS297	900p
74LS298	150p
74LS299	250p
74LS321	300p
74LS324/624	350p
74LS348	250p
74LS352	150p
74LS353	150p
74LS356	220p
74LS363	180p
74LS364	180p
74LS365	100p
74LS366	100p
74LS367	100p
74LS368	100p
74LS373	POA300p
74LS374	POA300p
74LS375	100p
74LS377	180p
74LS378	150p
74LS379	140p
74LS390	140p
74LS393	200p
74LS395A	140p
74LS399	210p
74LS445	180p
74LS465	220p
74LS467	220p
74LS490	170p
74LS540	200p
74LS541	200p
74LS608	700p
74LS610	1900p
74LS612	1900p
74LS626	350p
74LS628	350p
74LS629	300p
74LS640	250p
74LS640	1300p
74LS641	250p
74LS642	1300p
74LS643	250p
74LS643	1300p
74LS644	350p
74LS645	350p
74LS645	400p
74LS668	120p
74LS669	150p
74LS670	225p
74LS682	650p
74LS684	650p
74LS687	550p

74S SERIES

74S00	100p
74S02	100p
74S04	120p
74S05	100p
74S08	100p
74S10	100p
74S11	100p
74S20	100p
74S22	100p
74S30	100p
74S332	180p
74S37	180p
74S51	150p
74S74	120p
74S85	450p
74S86	180p
74S112	150p
74S113	120p
74S114	120p
74S124	550p
74S132	120p
74S133	100p
74S138	180p
74S139	180p
74S140	100p
74S151	200p
74S153	200p
74S157	300p
74S158	300p
74S163	400p
74S174	300p
74S175	320p
74S188	180p
74S189	225p
74S194	400p
74S195	400p
74S196	350p
74S200	450p
74S201	320p
74S225	650p
74S240	250p
74S241	300p
74S244	400p
74S251	300p
74S257	300p
74S258	300p
74S260	100p
74S261	300p
74S262	850p
74S283	300p
74S287	225p
74S288	180p
74S289	225p
74S299	650p
74S373	400p
74S374	400p
74S387	225p
74S472	475p
74S571	300p
74S573	500p

4000 CMOS

4000	30p
4001	30p
4002	30p
4006	90p
4007	30p
4008	90p
4009	60p
4010	60p
4011	30p
4012	30p
4013	60p
4014	80p
4015	80p
4016	50p
4017	75p
4018	75p
4019	60p
4020	90p
4021	80p
4022	80p
4023	50p
4024	50p
4025	30p
4026	100p
4027	50p
4028	60p
4029	90p
4030	45p
4031	160p
4032	80p
4033	160p
4034	200p
4035	80p
4036	270p
4037	150p
4038	80p
4039	250p
4040	80p
4041	60p
4042	75p
4043	75p
4044	75p
4046	90p
4047	85p
4048	60p
4049	48p
4050	48p
4051	80p
4052	80p
4053	80p
4054	90p
4055	90p
4056	100p
4059	450p
4060	90p
4063	90p
4066	45p
4067	290p
4068	30p
4069	30p
4070	30p
4071	30p
4072	30p
4073	30p
4075	30p
4076	90p
4077	30p
4078	30p
4081	30p
4082	30p
4085	60p
4086	70p
4089	125p
4093	48p
4094	100p
4095	90p
4096	90p
4097	290p
4098	90p
4099	90p
4501	40p
4502	60p
4503	60p
4504	90p
4505	400p
4506	120p
4507	45p
4508	160p
4510	75p
4511	75p
4512	75p
4513	140p
4514	130p
4515	130p
4516	75p
4517	200p
4518	75p
4519	75p
4520	75p
4521	125p
4522	90p
4526	90p
4527	90p
4528	75p
4529	90p
4531	75p
4532	80p
4534	400p
4536	220p
4538	90p
4539	90p
4541	90p
4543	100p
4551	250p
4553	220p
4555	60p
4556	70p
4557	250p
4560	120p
4566	200p
4568	300p
4569	200p
4572	50p
4583	75p
4584	48p
4585	65p
4724	150p
14411	900p
14412	850p
14416	300p
14419	300p
14490	550p
14495	450p
14500	700p
14599	350p
22100	350p
22101	700p
22102	700p
40014	48p
40085	90p
40097	60p
40098	60p
40100	120p
40101	120p
40102	140p
40103	170p
40104	120p

COUNTERS

74C925	£4
74C926	£5
74C928	£6
72168	£22
ZN1040	670p

LINEAR ICs

AD7581	£15
ADC0808	1190p
AN103	200p
AY1-5050	99p
AY3-1270	750p
AY3-1350	350p
AY3-8910	400p
AY3-8912	500p
CA3019A	100p
CA3028A	150p
CA3046	70p
CA3059	350p
CA3060	350p
CA3080E	80p
CA3086	60p
CA3089E	250p
CA3090AQ	375p
CA3130E	90p
CA3130T	110p
CA3140E	60p
CA3140T	110p
CA3160E	100p
CA3161E	150p
CA3162E	450p
CA3189E	300p
CA3240E	120p
CA3280G	225p
D7002	600p
DAC0800	200p
DAC0808	200p
DG308	300p
HA1366	190p
HA1388	250p
ICL7106	700p
ICL7611	95p
ICL7650	400p
ICL7660	250p
ICL8038	300p
ICM7216B	2400p
ICM7217	900p
ICM7555	100p
ICM7556	140p
LC7120	300p
LC7130	325p
LC7137	350p
LF347	150p
LF351	60p
LF353	100p
LF355	100p
LF356F	100p
LF357	130p
LF13331	350p
LM10C	325p
LM301A	25p
LM307	45p
LM308CN	75p
LM310	120p
LM311	70p
LM318	150p
LM319	160p
LM324	50p
LM334Z	90p
LM335Z	140p
LM339	40p
LM348	65p
LM358P	60p
LM377	225p
LM380	75p
LM381AN	180p
LM382	180p
LM386	90p
LM387	120p
LM389	180p
LM391	180p
LM392N	60p
LM393	100p
LM394CH	350p
LM709	50p
LM710	50p
LM711	70p
LM725C	300p
LM733	75p
LM741	20p
LM747	70p
LM748	40p
LM1011	480p
LM1014	150p
LM1801	300p
LM1830	250p
LM1871	300p
LM1872	300p
LM1886	500p
LM1889	350p
LM2917	250p
LM3302	75p
LM3900	50p
LM3909	120p
LM3911	160p
LM3914	350p
LM3915	350p
LM3916	350p
LM13600	110p
M51513L	230p
M51516L	500p
MB3712	200p
MB3730	400p
MC1310P	150p
MC1413	130p
MC1458	40p
MC1493	100p
MC1495L	350p
MC1496	70p
MC3340P	200p
MC3401	50p
MC3403	65p
MF10CN	360p
MK50240	900p
MK50398	790p
ML920	500p
MM6221A	300p
NE531	150p
NE544	190p
NE555	22p
NE556	50p
NE564	400p
NE565	150p
NE566	150p
NE567	140p
NE570	400p
NE571	400p
NE592	75p
NE5532P	200p
NE5533	160p
NE5534P	120p
NE5534AP	200p
PLL02A	500p
RC4136	60p
S566B	300p
SAA1900	£16
SAD1024A	1150p
SFF96364	800p
SN76477	600p
SN76489	400p
SN76495	400p
SP0256AL2	800p
TA7120	150p
TA7130	160p
TA7204	150p
TA7205	90p
TA7222	150p
TA7310	150p
TBA231	120p
TBA800	80p
TBA810	100p
TBA820	80p
TBA950	225p
TC9109	500p
TCA210	350p
TCA220	350p
TCA270	350p
TCA940	175p
TDA1004A	500p
TDA1010	250p
TDA1022	500p
TDA1024	120p
TDA1170	300p
TDA2002	325p
TDA2003	325p
TDA2004	300p
TDA2006	350p
TDA2020	320p
TDA2030	250p
TDA2541	400p
TDA3560	990p
TDA7000	350p
TL061CP	50p
TL062	75p
TL064	110p
TL071	45p
TL072	60p
TL074	110p
TL081	45p
TL082	55p
TL083	75p
TL084	100p
TL094	200p
TL170	50p
TL430C	120p
UA1003-3	935p
UA2240	120p
UAA170	200p
UCN4801A	350p
ULN2001A	130p
ULN2002A	130p
ULN2003A	130p
ULN2004A	130p
ULN2068	350p
ULN2802	250p
ULN2803	250p
ULN2804	250p
UPC575	275p
UPC592H	200p
UPC1156H	£3
UPC1185H	350p
XR210	400p
XR2206	400p
XR2211	575p
XR2240	120p
ZN414	80p
ZN419C	190p
ZN423E	130p
ZN424E	130p
ZN425E	350p
ZN426E	300p
ZN427E	600p
ZN428E	450p
ZN429E	210p
ZN450E	750p
ZN459CP	300p
ZN1034E	200p
ZN1040E	200p
ZNA134J	£23
ZNA234E	950p

VOLTAGE REGULATORS

FIXED PLASTIC

1A	+ve		−ve	
5V	7805	50p	7905	45p
6V	7806	60p	7906	45p
8V	7808	60p	7908	50p
12V	7812	50p	7912	45p
15V	7815	50p	7915	45p
18V	7818	60p	7918	50p
24V	7824	60p	7924	45p
5V 100mA	78L05	30p	79L05	45p
6V 100mA	78L06	30p		
8V 100mA	78L08	30p		
12V 100mA	78L12	30p	79L12	50p
15V 100mA	78L15	30p	79L15	50p

OTHER REGULATORS

LM309K 1A 5V	140p	78P05	900p
LM317K T03	250p	78H12	850p
LM317T	150p	78HGKC	600p
LM337T	225p	78HO5KC	650p
LM323K 3A 5V	450p	78GUIC	225p
LM350T	350p	79GUIC	250p
LM723N	50p	79HGKC	700p
TL494	300p	ICL 7660	250p
TL497	300p	LM305AH	250p
78S40	250p	SG3524	300p

OPTO ELECTRONICS

2N5777	48p
OCP71	180p
ORP12	120p
ORP60	120p
ORP61	120p
TIL32	55p
TIL78	55p
TIL31A	120p
TIL81	120p
TIL100	75p

OPTO ISOLATORS

ILD74	130p
MCT26	100p
MCS2400	190p
MOC3020	150p
ILQ74	180p
TIL111	70p
TIL112	70p
TIL113	70p
TIL116	70p
6N137	400p

LEDS

0.125″	
TIL209 Red	10p
TIL211 Gr	12p
TIL212 Yel	15p
0.2″	
TIL220 Red	10p
TIL222 Gr	12p
TIL228 Yel	15p
Rectangular LEDs (R,G,Y	30p

DISPLAYS

DL704	140p
DL707 Red	140p
FND357	120p
MAN72	140p
MAN74	140p
MAN4640	200p
MAN8910	250p
TIC729	140p
TIC730	140p
NSB5881	570p
TIL311	600p
TIL321/3	130p
TIL330	140p
7750/60	200p
Bargraph	225p

TRANSISTORS

AD161/2	45p
BC107/8	18p
BC109C	20p
BC169C	16p
BC172	18p
BC177/8	30p
BC179	30p
BC182/3	15p
BC184	16p
BC187	30p
BC212/3	16p
BC214	18p
BC237	16p
BC327	16p
BC337	16p
BC338	16p
BC461	40p
BC477/8	36p
BC516/7	50p
BC547B	20p
BC548C	12p
BC549C	16p
BC557B	14p
BC559C	24p
BCY70	30p
BCY71	36p
BD131	75p
BD132	80p
BD135/6	40p
BD139	40p
BD140	40p
BD189	60p
BD232	60p
BD233	75p
BD235	85p
BD241	60p
BD242	60p
BD379	60p
BD380	60p
BD677	40p
BF244B	40p
BF256B	50p
BF257/8	40p
BF337	30p
BFR39	32p
BFR40/1	32p
BFR79	32p
BFR80/1	32p
BFR96	180p
BFX29	45p
BFX30	45p
BFX84/5	30p
BFX86/7	30p
BFX88	40p
BFX89	180p
BFY50	30p
BFY51/2	40p
BFY56	33p
BFY90	90p
BRY39	45p
BSX19/20	30p
BU104	225p
BU105	190p
BU108	250p
BU109	225p
BU126	150p
BU180A	120p
BU205	200p
BU208	200p
BU406	145p
BUX80	600p
BUY69C	350p
E310	50p
MJ413	250p
MJ802	400p
MJ2501	225p
MJ2955	90p
MJ3001	225p
MJ4502	400p
MJE340	60p
MJE2955	150p
MJE3055	120p
MPF102	40p
MPF103/4	40p
MPF105	40p
MPSA06	30p
MPSA12	50p
MPSA13	50p
MPSA20	50p
MPSA42	50p
MPSA43	50p
MPSA56	30p
MPSA70	50p
MPSA93	40p
MPSU06	63p
MPSU07	60p
MPSU45	90p
MPSU65	78p
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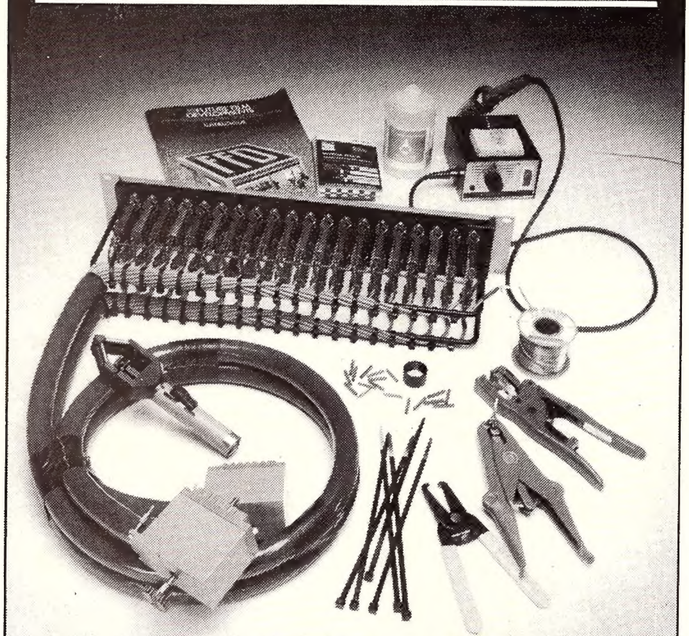

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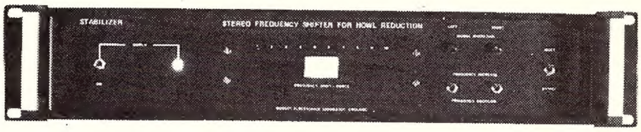

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lyperthermia rogress

Iuch attention in recent years as been focused on radiation azards very close to high-power adio transmitters. Less notice as been taken of the advances eing made in the medical use of f. heating by h.f., v.h.f. and icrowave transmitters, articularly for hyperthermia eatment of malignant cancer imours. Although hospitals ave used heating by r.f. power liathermy) for about 50 years, ecent work has concentrated on ie development of more ffective coupling of the r.f. ower into the affected part of the ody by means of improved ipplicators'.

A recent report from the iomedical Engineering and istrumentation Branch of the merican National Institutes of Iealth in Bethesda, Maryland, otes that while hyperthermia ffers promise as an adjuvant to ancer therapy, so far little uccess has been achieved in eating deep-seated tumours. A ew design of helical coil pplicator has been developed vhich in tests under simulated onditions of the fat-iuscle-bone of a human arm r thigh appears to be both ractically and theoretically apable of producing deep ieating (*IEEE Trans* 1984 ol.BME-31, pp.98-106, and *Electronics Letters*, 1984, ol.20, April 12, pp.337-8). Iyperthermia uses r.f. power to aise the temperature of tumours o around 43-45°C instead of the iormal body temperature of ibout 37°C. It has been known or over a century that some nalignant tumours respond to ocalized but small elevation of emperature. The difficulty has ieen to heat the affected organ vithout overheating other parts f the body. The Bethesda work ias used the industrial, scientific ind medical frequencies of 13.56, 27.12 and 40.69MHz. Other workers have concentrated on microwave hyperthermia on 2450 and 915MHz despite its imited depth of penetration of oughly 1cm for loads of high vater content, such as muscle, orain and organs. Design of ipplicators that can improve the ieating of tumours deep within ayers of fat or bone, with ninimum absorption of energy elsewhere has proved difficult and the Bethesda work on helical coil applicators appears to be in the nature of a breakthrough.

A number of British hospitals are involved in hyperthermia experiments, some making use of obsolete 405-line v.h.f. television transmitters which can be modified for this type of work. IBA have already donated several Band III equipments to hospitals in Aberdeen, Bristol and Cambridge and have earmarked further equipments for this purpose when Band III television is finally phased out in January 1985.

Telecommunications Act

The Telecommunications Act, 1984 received Royal Assent on 12 April, 1984 and Part VI – provisions relating to wireless telegraphy, incuding amendment and enforcement of the Wireless Telegraphy Acts – will shortly become law. The new Act appears to provide the DTI with the means of stamping out unauthorized and illegal use of transmitters of all types, provided always that sufficient effort is put into tracing them.

Manufacturing, selling, offering for sale or hire of 'restricted' apparatus becomes for the first time an offence. Having 'without reasonable excuse' such equipment in one's custody or control, or importing it, will also be an offence. Manufacturing includes assembly of component parts.

Immediate seizure of equipment under a search warrant becomes possible; if there is any doubt as to identity or address not even a warrant is necessary. Where such seizure is later confirmed by the Court, the Secretary of State can, as at present, dispose of it as he thinks fit.

The Act also makes provision for payment of the radio Interference Service from money provided by Parliament and operational responsibility for this service will be transferred from British Telecom to DTI.

The Act abolishes the advisory committee of the 1949 Act and strengthens the powers of the licensing authority in a number of ways including the ability at any time to revoke or vary the terms of any broadcasting or communications licence 'in the interests of national security or relations with the government of a country or territory outside the UK'.

Sending of false or misleading messages becomes an indictable offence. DTI have the right to prescribe technical requirements for services.

It remains to be seen how strictly the Courts will interpret the amended Wireless Telegraphy Acts and the effort that will be put into enforcing them. On the face of it it would seem to be an instrument capable of quickly putting off-air the broadcasting 'pirates' and the more numerous pseudo-amateurs such as the 'International C.B.' around 6.6MHz. Less easy to suppress will be the unlicensed 'amateurs' and 'c.b.' operators who may still find it possible to pass unnoticed for a time by operating in accordance with the licences they have omitted to obtain.

It seems likely that concessions will be made soon to small-time broadcasters by the introduction of some form of 'community radio' or 'special event' radio licence involving for example low-power transmitters at major outdoor and sports events. This may however be deferred until the end of the second session of the ITU Regional Administrative Conference at Geneva next October to December, when frequency assignments between 100-108MHz are expected to be agreed for the European region.

Vienna Convention

The events during April surrounding the 'siege' of the Libyan People's Bureau were calculated to re-inforce the very worst fears of signals intelligence people. The American ABS network started the ball rolling by claiming that Libyan messages to London had been intercepted, deciphered but then not passed on to the police in time for them to take greater precautions during the morning of April 17. Such a 'leak' apparently from American sources, if true, must rank alongside the three classic occasions in the 1920s when it was openly revealed in the British Parliament that Russian diplomatic traffic was being read. This led inevitably to the USSR introducing secure ciphers and the loss of a valuable source of information. As a result British Intelligence became very wary of passing sigint even to the Cabinet.

Today diplomatic traffic can be unconditionally secure (truly random : one-time' keys) or more often-'computationally secure' requiring excessive computer time to crack. Clearly some of what can be plucked form the air can still be read, if only with difficulty, or signals intelligence would not have retained its importance. But the idea that almost all diplomatic traffic can be read immediately on receipt can serve only to encourage the Libyans (who *know* whether they sent such a message) and other countries to change to more secure ciphers.

The leak furthermore served no useful purpose. WPC Fletcher was already dead. If NSA or GCHQ are able to decipher such messages virtually without dealy, it may indeed have been blame-worthy that a warning did not reach the Metropolitan Police before the shooting. But finding a scapegoat is a doubtful advantage if in the process a source is blown.

Diplomatic radio communications form one of the fixed services not entirely transferred to satellite. A stroll though Belgravia or other embassy districts of London reveals many h.f. aerials ranging from very large log-periodics to the barely visible compact transmitting loop aerial on the roof of the US embassy in Grosvenor Square. Diplomatic communicatons remain an important market for h.f. equipment.

Foreign embassies, however, do not have an automatic right to set up radio links. Paragraph 1 of Article 27 of the Vienna Convention on Diplomatic Relations, 1961 reads: 'The receiving state shall permit and protect free communication on the part of the mission for all official purposes. In communicating with the Government and the other missions and consulates of the sending State, wherever situated, the mission may employ all appropriate means, including diplomatic couriers and messages in code or cipher. However the mission may install and use a wireless transmitter only with the consent of the receiving State.'

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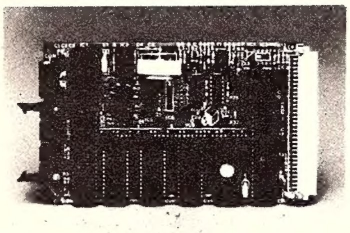

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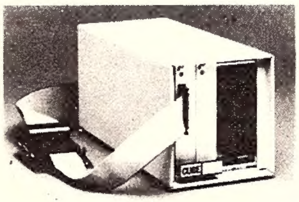

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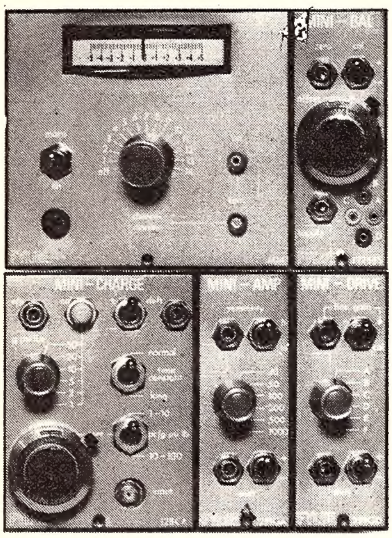

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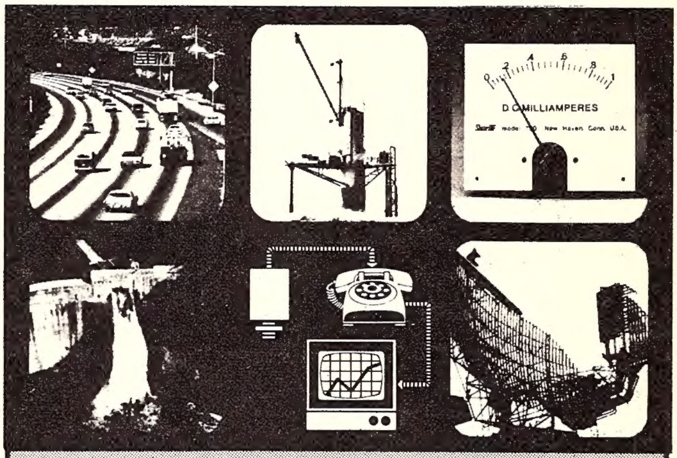

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CIRCLE 42 FOR FURTHER DETAILS.

CD camera

t NAB, RCA introduced a lid-state portable broadcast mera based on charged-upled device sensors d a 'frame transfer' process. riced $37,000 the camera is aimed to provide a signal/noise tio of 62dB with high nsitivity and absence of smear moving objects. C.c.d. meras have been under evelopment for at least ten ears, but many difficulties have d to be overcome for oadcast-quality units, and udio cameras may still be some ay off. Largest exhibit at NAB as mounted by Sony orporation at a cost of over 1-million. They featured their in Betacam integrated mera/recorder and a complete gh-definition system....NBC ave begun distributing network rogrammes to 22 affiliate ations via satellite and plan to crease this to 150 stations by arly 1985... About 17-million S homes (19% of tv homes) now ave v.c.r. machines, still gnificantly below UK enetration.

Amateur Radio

Moonbounced TV?

ndrew Emmerson, G8PTH, has assed along news from Maurice lot, F1FVX, of what promises o be a remarkable and unique xperiment aimed at gaining a world first' in amateur elevision. French amateurs are o attempt moonbounce of elevision signals transmitted on 1255MHz using an aerial with a alculated gain of the order of 90dB!

To make this possible, the rench electricity authorities have granted permission for F9CH and F6BGR to use the 10,000 square-meter plane metal reflectors of the French experimental solar oven near Fontromue, East Pyrenees as an aerial, with a dipole element replacing the normal crucible and with the computer programmed to follow the moon instead of the sun.

It is planned to use frequency-modulated vision signals with a transmitter power of 140 watts during tests between July 9 and July 13 when the moon will be low enough on the horizon (20 to 24° at the meridian) to allow receiving stations to aim their aerials without the need for an elevation rotor. Further information on these experiments is to be distributed through French stations on 144.170MHz ± 10kHz and 3670 ± 10kHz.

Here and there

The Australian society, WIA, has succeeded in persuading their Government to re-establish the special low import tariff (2%) on amateur transmitters and transceivers. This concession was lost in June 1983 when an Australian manufacturer of marine communications equipment complained that some imported amateur radio equipment had been modified and illegally sold for use in the maritime service. The low import tariff was granted on the basis that there is no Australian production of amateur h.f. transceivers.

The Olympic Games torch run that starts on the East Coast of the USA and will pass through all the 48 contiguous States before it ends at the Los Angeles venue on July 28 is being co-ordinated by amateur radio communicators travelling in the fleet of support vehicles, under the aegis of AT&T.

Several Australian amateurs have been granted experimental permits permitting transmission on 196kHz (1830 meters) on condition that only 'backyard' aerials are used. With output powers of about 100 watts and fairly short aerials about 10m high, resulting in effective radiated powers of less than 0.5-watt, telegraphy contacts are being made over distances of several hundred miles.

A successful meeting of Dutch amateurs interested in narrow-band mechanical television was held last March in Eindhoven, attracting 50 to 60 visitors. Historic 30-line equipment was displayed by Kees Sanders, PAoDXY. A camera monitor by P. Wakker was made from small lenses taken from a broken road sign and driven by a bicyle dynamo. Several British NBTV enthusiasts have been using silicon solar cells as pick-up devices for low-definition systems. A 96-mile mechanical system being developed by J.A. Short uses the old Baird techniques of obtaining sync signals by blanking off part of the picture (i.e. no blacker-than-black pulses) but uses a much more sophisticated form of sync-separator discriminator. Apparently it works, which is more than could always be said of the Baird phonic-wheel technique!

Wayne Green, W2NSD, editor of *73 Magazine*, in a petition for rule-making submitted to the FCC has proposed that all American radio amateurs should be re-examined for morse proficiency every two years with a requirement that they achieve a five word-per-minute up-grading each time, to a final level of 35 word/min. Failure to improve speed, he suggests, should result in loss of licence. However it seems highly unlikely that FCC will impose such a rule.

Region 1 Conference

At the 1984 IARU Region 1 Conference held at Cefalu, Sicily, Dr John Allaway, G3FKM, was elected as secretary of the Region 1 Executive Committee, the post held until his death in 1981 by Roy Stevens, G2BVN and since then by Eric Godsmark, G5CO. Region 1 conferences are held once every three years. At this year's conference, member-societies were urged to seek from their national adminstrations a 50MHz amateur allocation and the removal of Syledis pulse transmissions from the 430MHz band. The conference also recommended that no f.m. repeaters should operate between 144.8 and 145MHz and rejected proposals to allocate channels and repeater channels for narrow-band f.m. transmissions in the 29MHz band. It endorsed a provisional band-plan for 1296MHz and a new world-wide locator-squares system (from January 1, 1985). The IARU Medal was awarded to the Russian amateur N. Kazansky, UA3AF. The conference also discussed the proposed new constitution for the International Amateur Radio Union.

Rather more success in dealing with interference from Syledis-type transmissions in the 430MHz band is reported from California where pulse transmitters on 433 and 437MHz have now been turned off.

In brief

A major solar flare, possibly the largest in Solar Cycle 21, was recorded at the end of April .... The RSGB 1984 National Convention at NEC Birmingham attracted over 6000 people on Saturday 28 April and some 5000 on the Sunday. The 1985 Convention is to be held at the National Exhibition Centre on 13 and 14 April 1985 ... A postage stamp featuring the amateur radio station, H44SI, of the Solomon Island amateur radio society was issued last December as one of a set of three stamps forming a World Communications Year set ... During early June, French amateurs operated a special station, TK6JUN, at Ste Marie-du-Mont (Utah Beach) to mark the 6 June, 1944 D-Day landings by Allied forces. On this side of the Channel, GB4BLC operated from the Royal British Legion centre at Nettley, Southampton as part of an 'Operation Overlord' project during the D-Day anniversary week ... RSGB annual subscription is being increased by £2 to £16.50 from July 1 ... In a recent prosecution for the illegal use of 6.6MHz transmitter, Robert Burwell was fined £250 with £50 costs. It was stated that French air traffic control had complained of interference to its operations caused by the transmitter ... July mobile rallies include: Worcester club at Droitwich High School, Ombersley Road on July 1; West Manchester club at Burtonwood Motorway Service Area near the junction of M6 and M62 on 8 July; Cornish club at Camborne Technical College, Pool on 15 July; West Kent Radio and Electronics Fair at Royal Victoria Hall, Southborough on 21 July; Anglian rally at Stanway School, Colchester and McMichael rally at Bells Hill, Stoke Poges both on July 22; Rolls Royce rally at Sports & Social Club, Barnoldswick and Scarborough rally at The Spa, Scarborough both on July 29 -

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225	3v-30v	0-120	11.50	2.50	2.10	16.10
300	3v-30v	0-120	13.50	2.50	2.40	18.40
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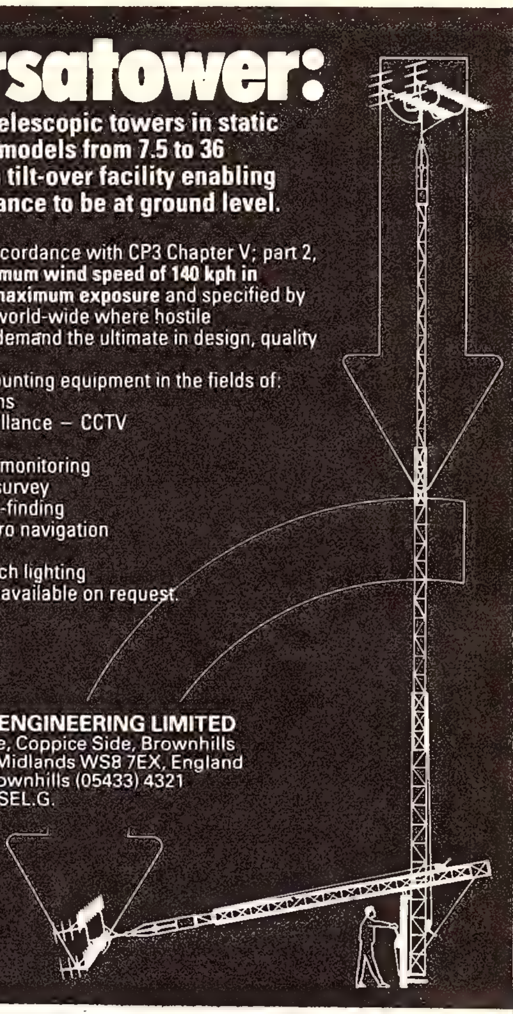

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CIRCLE 61 FOR FURTHER DETAILS.

Computer crashes

No less than three different computer companies ceased trading in one week: Dragon Data, Tycom and Camputers. The chief executive of Tycom is Sir John Clark, Conservative Members of the European Parliament. His major customer has been the Conservative party, who have installed the Microframe computer in a large number of constituency offices. The party is now looking for ways to provide services and hardware support to those constituences. Brian More of Dragon Data feels that the bouancy of the home computer market has been overestimated and that most people who get home computers do it purely and play games or because they are curious about computers. He is looking for a buyer, and one may be at hand. Tandy Corporation, whose Color Computer is very similar internally to the Dragon 32, has expressed an interest, initially in taking over the servicing and repair of the Dragon but possibly in continuing the manufacture as well. Camputers, manufacturer of the Lynx computer which never really got off the ground, having sold only some 10 000 units, are also looking for a buyer.

The business computer market is now greatly influence by the coming of the IBM personal computer. Such large corporations can use their capita and their marketing expertise to produce a machine that is easy t mass produce, and can provide full documentation and support in both hardware and software. The smaller companies such as Tycom find it difficult to compet with such powers.

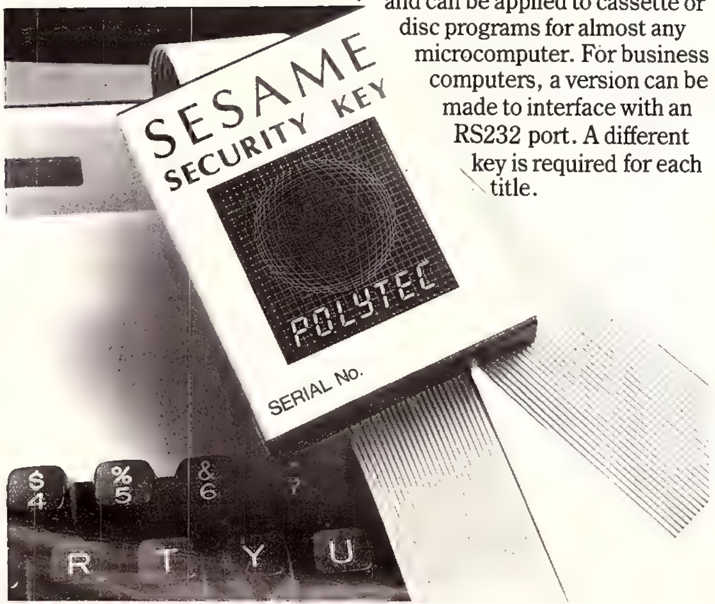
Software Key

A fresh attempt to counter home software piracy has been launched by the Cornish company Microdeal, with the inclusion of the protection device with one of their latest computer games.

Buzzard Bait, a game for the Dragon 32, comes with a small resin-encapsulated module which plugs into one of the computer's joystick ports. This software key, as Microdeal call it, must be in place to enable the cassette to load properly. The company hopes the device will put an end to unauthoried tape-to-tape copying, since without it the cassette is useless. And Microdeal believe that copying the module itself would call for resources beyond those of the home user. The key, or dongle, was developed to Microdeal's specification by Northern Software Consultants of Newcastle-upon-Tyne. It costs about £2, and can be applied to cassette or disc programs for almost any microcomputer. For business computers, a version can be made to interface with an RS232 port. A different key is required for each title.

Microdeal will be adding the key to several new programs on their Tom Mix Software label. They hope to discover whether increased sales to frustrated pirates will outweigh those lost to schoolchildren who might otherwise have bought the game by pooling their pocket-money.

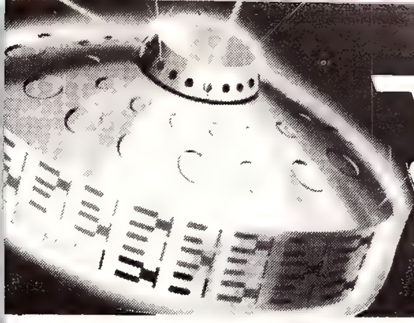
● Also fitting in to the RS232 port of a computer is the Sesame security key from Polytech Engineering Services Ltd. Without inhibiting the use of the port, any software used with the system interrogates the key which responds only if the correct password is used. Any copy of the software will only work on a computer fitted with the same key and as there are approximately 100 million possible codes, made up out of ASCII control characters, in effect this means only one computer can use it. Each devic is supplied with a randomly selected code, together with notes and a flow-chart on how to incorporate the interrogation routine into a program. It has been estimated that it would tak a fast computer about 20 years t 'crack' the code. WW230



Cell news

Trials for Racal's cellular radio-telephone system, to be known as Vodafone, are to start in December 1984, ahead of the original schedule, over a 150 square-mile area of London. The service will also start up before its schedule date of March 1985, initially covering London, cities in the south, Wales and the midlands, and along several motorways. The second phase is to be an expansion into the north of England — plans for Scotland and Northern Ireland are to be announced later this year. Racal have also launched a new company, Racal-Vodac, to distribute, install and service subscriber equipment. Another company was necessary as the licencee for the system is not permitted under the terms of the licence from marketing the consumer equipment.

Consumer equipment for the BT/Securicor Cellnet system is to be manufactured in Japan by NEC. After a world-wide search for a manufacturer to these products, BT decided that NEC were the only people with the facilities and expertise to provid the system. The equipment will include both car-mounted mobil radiophones and hand-held portables. The mobile sets will be available in December this year with the portables following later in 1985. If the cellular system is as successful and popular as both BT and NEC think it will be then there is a chance of manufacturing facilities being transferred to the UK. The first working pilot system of Cellnet was to be demonstrated in London early in June to cover 3 000 square miles and give continuous coverage over central London, extending to Heathrow and Gatwick Airports.



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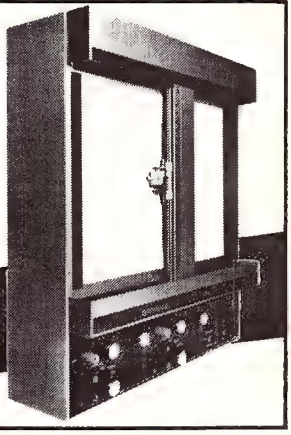

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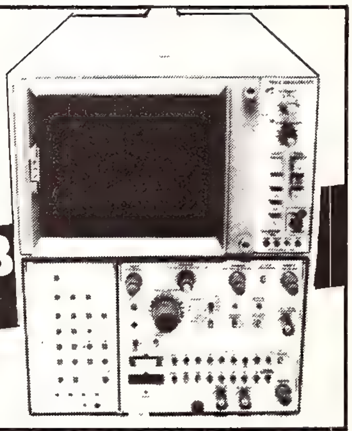

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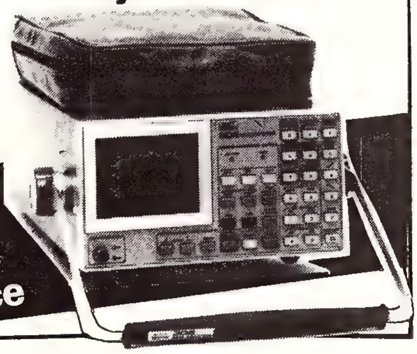

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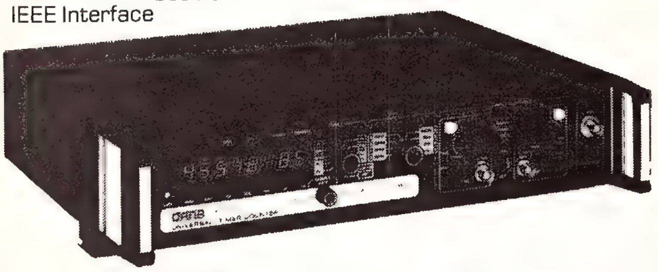

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CIRCLE 203 FOR FURTHER DETAILS.

Uosat 2 not dead but poorly

Uosat-2, the Surrey University satellite which ceased to transmit beacon signals after the first three orbits, has now been traced. (Communications Commentary, last month) The giant SRI dish in Greenland managed to detect the 1.2GHz local oscillator which pin-pointed the exact orbit of the craft. Surrey engineers were gratified to have confirmed that the satellite was where they expected it to be. They managed to turn on the 2MHz beacon to discover that the satellite was undergoing a weekly temperature cycle and that there were major problems with the 2MHz beacon system. Now they have managed to bypass the problem by using the on-board computer and have been able to send commands on the command uplink. It is still necessary to stabilize the craft to prevent the temperature cycling and to get the main antenna pointing earthwards. Then it will be possible to have a complete system check-out and find out how many of Uosat-2's functions are still working. Even if everything else functions propertly, it will not all be able to be used because of the use of the computer to bypass the 2MHz problems.

OED on computer

The compilers of the new edition of the Oxford English Dictionary have decided to commit it to a computer. This will enable the original 13 volumes to be expanded by the four supplement volumes and any new words can be easily inserted right up to the moment that the edition is prepared for printing. There are over half-a-million entries which include over two million illustrative quotations giving a total of over 80 million characters. In addition there is a variety of typefaces including Greek, phonetic characters, mathematical symbols and scientific formulae.

The system is to be based around an IBM 4341 central processor with both tape and disc storage, printers and over 20 v.d.us. Under IBM's scheme for support for academic institutions they are sending two data-processing specialists to the OUP to assist the dictionary editors with the task of updating.

One network not two in UK

Britain is urged not to follow the American example and have separate telephone and tv networks. In an article in the *Sunday Times* of June 4th, Warren Partridge an American lawyer and telecommunications business consultant, points out that with the denationalization of British Telecom, Britain is heading toward the same system that the US has developed in the 70s: one that has a private telephone monopoly, underfunded cable tv and unnecessary investment in all sorts of services to be carried into homes on several wires. Now is the time, he maintains, for all these services to be combined into one network.

The American experience is the development of two separate, and inadequate, systems. The telephone network is neither designed for local transmission of high-speed data nor tv pictures; the other, a cable tv system is not designed to provide telephone services. Both systems suffer from not getting the income that could accrue from the services provided by the other.

Mr Partridge suggests that Britain's cable tv franchising process could be used as the mechanism for privatizing BT. Britain could be divided into a few large combined telephone and cable services. The condition attached to awarding a franchise should be the aquisition of BTs present telephone system assets. This would privatize BT geographically, piece by piece, with the licensee operating a single system for telephones and tv. Those awarded franchises should offer a common carrier service only and lease capacity for tv channels or other services to programming and marketing companies. Control of such entertainment channels could be through the proposed cable authority.

These proposals would counter the problems found in the US, where it has been found that cable tv only provides more channels and if those channels are also available over the air then the cable systems begin to founder. Only in Washington DC has the telephone company proposed that they provide the cable system to be leased to cable tv companies. That should be the way forward for Britain, says Mr Partridge, if it wants to learn from US mistakes and take its telecoms into the futue.

Communications in the air

British Telecom persuaded British Caledonian to run part of its Gatwick operation from Birmingham at Communications 84. They did this to demonstrate the capabilities of Touchdown, a communications link between the aircraft, controllers and groundstaff which allows for the arrangement of schedules for re-fuelling and repairs, check destination and arrival times, book crews and aircraft, check passenger loads and the provision of on-flight catering. All this is done from a touch-screen terminal. By touching squares on the screen operators can answer incoming calls, call up background information, make internal and external calls (all regular numbers are stored and dialled automatically), and send or receive telexes. The link from Gatwick to Birmingham was for two of the 12 terminals in use at Gatwick.

Another communications system, installed by BT at Gatwick, is for the air traffic controllers. Through ADEKS, Advanced Design Electronic Key System, allows controllers to get in instant touch with other controllers and with telephone lines. Mike Morris, a director of BT National Networks, expressed his pleasure at receiving the order from the Civil Aviation Authority. He hoped that similar organizations in other countries would follow suit. The system combines 'sophisticated features and high reliability, at an extremely competitive price. ADEKS was designed specifically for installations such as this and is the result of cooperation between BT and CAA communications engineers.'

ADEKS keyboards are small units incorporated into the air traffic controller's desks. At the touch of a button users have instant access to all kinds of internal, public and emergency telephone lines. Incoming calls are indicated according to their priority.

The control system is designed to minimize disruptions and uses multiple processors and back-up cable routes to ensure high integrity. Any components failure can effect a maximum of one console or two lines. Self-checking routines and battery back-up are also provided. Cables are smoke and fire resistant and special immunity to radar and radio interference has been built in. One system can handle up to 116 lines to 60 consoles and systems may be linked for larger installations. ADEKS can also be interfaced to radio circuits. ADEKS is installed in the new stalk-mounted control tower at Gatwick.

Expanding American teletext

National Association of Broadcasters has joined the FCC in its proposals to authorise American tv stations to provide paging and a variety of data transmission services in the tv signal vertical blanking interval. The services should include video games and computer programs, and other 'interactive' services. The decision to provide these services should be left to the market place. In its submission, the NAB said that the system was technically sound, promoted competition and conductive to spectrum efficiency. It also said that the services should not be subject to common carrier regulation. Cable services which are obliged to carry certain network services should not be permitted to 'strip' the new offerings from the tv signals.

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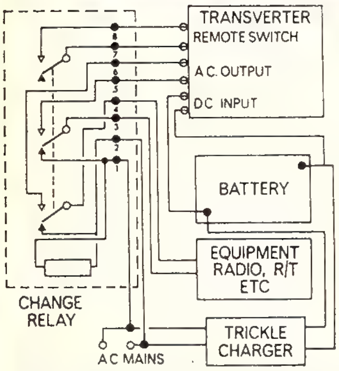

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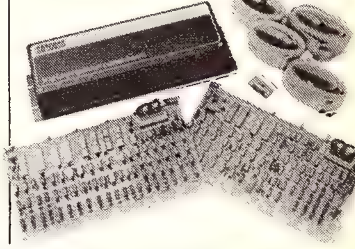

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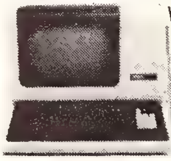

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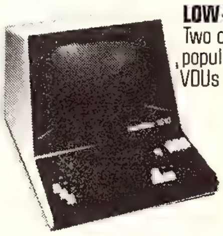

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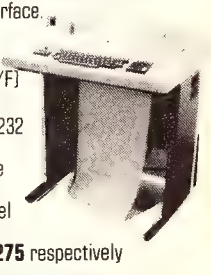

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EZ35	1 85	5SR6	6.00	6Q11	2 55	5870L	20 00		
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EZ80	1 95	5UPI	40 00	6SL7GT	1 95	5876A	27 60		
EZ81	1 65	5V4GA	2 75	6SN7GTB	2.85	5879	3 80		
EZ90	2 00	5Z4GT	1 90	6SR7	3 80	5886	14 90		
FG17	24 50	6AH6	3.50	6U4	1 50	5894A	41 25		
FG105	95 00	6AJ8	2.50	6U8A	2 00	5894B	45 00		
GXU1	15 00	6AK5	3 90	6V4	1 95	5920	8 50		
GXU4	37 50	6AK5W	2 90	6V6GT	1 95	5963	1 80		
GXU5	120 00	6AK6	1 95	6X4	2 00	5965	2.20		
GZ34	3 50	6AL5	1 95	6X5GT	1 85	5991	20.00		
KT66	6 90	6AL5W	1 80	6X8A	3 00	6005	1 90		
KT77	8 75	6AM5	9 10	6Y9	2 95	6011	29 90		
KT88	15 95	6AM6	2 95	7F7	9 50	6012	9 90		
KU72Z	280 00	6AN8A	2 70	7K7	10.85	6014	20 00		
L5047	890 00	6AQ5A	1.95	8CG7	2.00	6021	3 70		
M8223	5 50	6AQ5W	1 90	8FQ7	2 00	6058	10 50		
M8224	5 95	6AQ8	2 20	9SP4	88 00	6063	3 70		
MD1901	10 00	6AR5	2 85	12AT6	1 70	6065	7 25		
ML7815	96 00	6AS6	5.50	12AT7	1 60	6073	5.50		
ML8536	220 00	6AS7G	7 20	12AU6	2 00	6080	9.20		
ML8741	215 00	6AU5GT	4 50	12AU7A	1 60	6083	72 00		
MU7235	66 00	6AU6A	1 80	12AV6	2 00	6084	13 10		

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2N3632	10 00	2SC1122	18 00	2SC2369	2 00	MRF433	16 21	SD1020	1 50
2N3733	13 20	2SC1162B	0 90	2SC2370A	18 00	MRF449A	14 95	SD1074	16 10
2N3866	0 85	2SC1165	6 95	2SC2379	15 00	MRF450	11 90	SD1076	18 50
2N3926	11 26	2SC1169	4 85	2SC2395	15 00	MRF453	14 00	SD1077	1 60
2N3927	11 82	2SC1176	14 00	2SC2407	1 00	MRF453A	14 00	SD1078	26 50
2N4416	0 75	2SC1177	17 25	2SC2420	18 00	MRF454	21 00	SD1080	1 55
2N4427	0.75	2SC1178	18 00	2SC2494	16 00	MRF454A	24 00	SD1080-6	7 50
2N5090	13.90	2SC1209D	0 64	2SC2509	6 00	MRF455	16 00	SD1080-7	7 50
2N5109	2 00	2SC1213A	0 40	2SC2531	1 30	MRF455A	21 00	SD1088	26 00
2N5160	4 80	2SC1213C	0 40	2SC2538	1 10	MRF458	19 95	SD1089	28 50
2N5190	1.50	2SC1239	2 50	2SC2539	15 00	MRF466	24 50	SD1098	40 10
2N5589	6 00	2SC1241	15 00	2SC2540	24 95	MRF472	4 40	SD1115 2	7 50
2N5590	8.50	2SC1251	10 00	2SC2545E	0 29	MRF475	2 00	SD1115-7	2 10
2N5591	8 90	2SC1260	1 11	BFR90	1 50	MRF475	2 25	SD1127	2 50
2N5643	13 00	2SC1303	5 00	BFR91	2 00	MRF477	12 50	SD1131	3 25
2N5913	2 50	2SC1306	1 00	BFR96	2 00	MRF492	27 50	SD1133	9 50
2N5945	8 95	2SC1307	1 50	BFY90	1 50	MRF497	18 50	SD1133 1	10 00
2N5946	15 63	2SC1311	0 40	BLW29	10 00	MRF515	3 90	SD1134-1	2 50
2N6080	6 00	2SC1311E	0 32	BLW60C	15 00	MRF517	3 50	SD1134 2	10 00
2N6081	8 75	2SC1314	25 00	BLW60CF	15 00	MRF620	18 00	SD1134-8	10 00
2N6082	9 00	2SC1318	0 40	BLW64C3	65 00	MRF644	27 50	SD1134-STUD	7 60
2N6083	12 00	2SC1368B	1 00	BLW78	61 80	MRF646	28 00	SD1135	10 25
2N6084	13 20	2SC1383B	0 50	BLW80	10 25	MRF648	33 00	SD1135 3	12 00
2N6094	8 00	2SC1424	1 35	BLW81	14 90	MRF750	6 50	SD1136	12 50
2N6095	8 50	2SC1509	6 00	BLW90	13 00	MRF846	46 00	SD1143	9 45
2N6255	3 45	2SC1546	0 45	BLW98	110 00	MRF901	2 75	SD1143 1	10 00
2SC382	0 65	2SC1568	0 45	BLX39	13 75	MRF904	2 95	SD1144 1	2 50
2SC458	0 22	2SC1589	5 00	BLX65	2 45	MRF911	2 50	SD1158	7 95
2SC458B	0 36	2SC1622	0 33	BLX67C	9 50	MRF5175	22 50	SD1201	7 35
2SC458C	0 22	2SC1623	0 30	BLX67CF	9 50	MRF5176	30 00	SD1202	7 50
2SC460	0 25	2SC1688	19 80	BLX68C3	10 00	MRF5177	43 00	SD1212 4	6 00
2SC460B	0 25	2SC1674	0 25	BLX68CF	10 50	MRF8004	2 00	SD1212 7	4 00
2SC461B	0 25	2SC1675	0 20	BLX69A	20 00	PT3134A	1 50	SD1214	8 70
2SC535	0 38	2SC1678	1 25	BLX94A	36 00	PT3134B	2 75	SD1216	11 00
2SC535A	0 38	2SC1729	18 00	BLX98	132 00	PT3134C	12 00	SD1219	18 00
2SC535B	0 38	2SC1730	0 25	BLY87C	7 50	PT3134D	12 50	SD1219-4	18 00
2SC535C	0 35	2SC1740Q	0 20	BLY88C	11 00	PT3134E	30 00	SD1220-1	9 50
2SC540	24 95	2SC1765	7 75	BLY88CF	11 00	PT3161A	1 75	SD1222-5	11 00
2SC608	0 75	2SC1815Y	0 28	BLY89C	13 00	PT3161B	1 75	SD1222-STUD	11 00
2SC644	0 25	2SC1906	0 33	BLY90	45 00	PT3161C	8 50	SD1224 2	13 00
2SC684	0 28	2SC1907	0 30	BLY91CF	11 00	PT3161D	14 00	SD1229-F1	10 95
2SC703	36 00	2SC1945	2 10	BLY94	45 00	PT3161F	30 00	SD1229-STUD	10 95
2SC710	0 45	2SC1946	19 75	MRF208	12 00	PT3503	6 95	SD1244-6	12 75
2SC710D	0 28	2SC1946A	16 50	MRF212	12 00	PT4261A	16 00	SD1256	6 95
2SC715D	0 40	2SC1947	9 88	MRF221	12 05	PT4261B	24 00	SD1262	15 00
2SC715E	0 40	2SC1955	7 20	MRF229	3 50	PT4261C	60 00	SD1270	3 75
2SC717P	0 38	2SC1966	11 00	MRF231	12 36	PT4316C	12 00	SD1272	10 95
2SC730	4 10	2SC1967	15 00	MRF232	13 50	PT4316D	18 00	SD1272-2	10 95
2SC731	3 95	2SC1968	17 50	MRF233	14 30	PT4316E	25 00	SD1278	13 75
2SC732	0 25	2SC1968A	22 00	MRF234	16 00	PT4316F	30 00	SD1278-1	13 75
2SC741	2 50	2SC1969	3 05	MRF237	3 10	PT5661C	14 00	SD1285	12 75
2SC821	6.60	2SC1970	1 50	MRF238	12 60	PT8751	24 00	SD1300	1 25
2SC828B	0 30	2SC1971	4 00	MRF239	20 00	PT8820	15 00	SD1303	2 50
2SC829B	0 25	2SC1972	11 00	MRF240	24 50	PT8831	2 75	SD1316	2 10
2SC890	8 50	2SC1978	7 50	MRF243	35 00	PT8837	10 00	SD1317	8 00
2SC891	18 00	2SC2001	0 45	MRF245	30 00	PT8838	15 00	SD1405	21 00
2SC900	0 18	2SC2026	0 75	MRF247	30 10	PT8854B	18 00	SD1407	27 50
2SC900F	0 19	2SC2053	0 80	MRF260	5 00	PT8861A	15 00	SD1407MP	55 00
2SC908	4 50	2SC2097	36 00	MRF264	11 00	PT8864A	30 00	SD1410	21 06
2SC911A	18 00	2SC2099	15 00	MRF309	42 00	PT8874	18 00	SD1410-1	21 00
2SC945	0 21	2SC2100	24 00	MRF316	55 00	PT9795	12 50	SD1410-3	21 00
2SC945R	0 21	2SC2103	18 00	MRF317	73 00	PT9797	14 00	SD1412	36 00
2SC952	0 60	2SC2105	15 00	MRF321	35 00	PT9841	16 00	SD1412-3	24 00
2SC982	0 30	2SC2116	1 60	MRF323	35 00	PT9847	16 00	SD1413	18 00
2SC994	2 50	2SC2118	9 00	MRF326	63 00	SD1005	8 20	SD1414	36 00
2SC998	3 90	2SC2221	5 50	MRF327	70 00	SD1006	2 10	SD1416	33 00
2SC1001	9 90	2SC2233	0 90	MRF329	58 06	SD1012-3	10 00	SD1418	30 00
2SC1011	15 00	2SC2237	16 00	MRF412	18 51	SD1012-4	10 50	SD1421	36 00
2SC1070	1 15	2SC2281	13 00	MRF421	36 85	SD1013	10 00	SD1428	24 00
2SC1096L	0 90	2SC2283	9 00	MRF422	42 00	SD1014 6	10 50	SD1429	15 98
2SC1096M	0 90	2SC2287	11 00	MRF426	23 00	SD1015	17 50		
2SC1117	1 50	2SC2289	12 50	MRF427A	21 00	SD1018-6	13 00		

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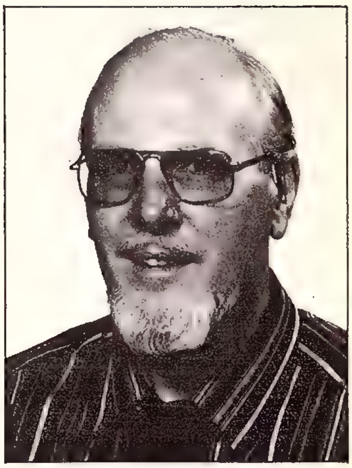
CIRCLE 66 FOR FURTHER DETAILS.

Digital stereophony with television

by E. H. Hartwell
BBC Research Department

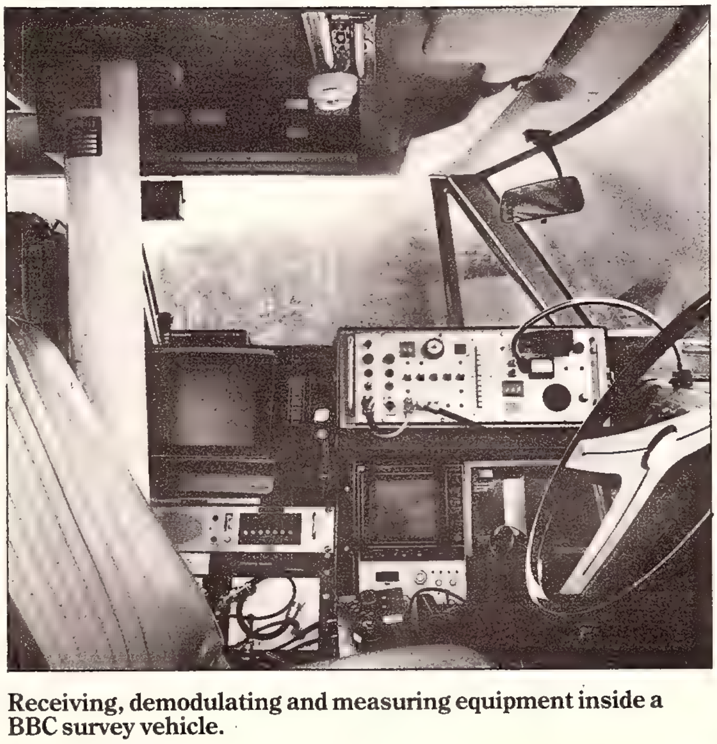


Ted Hartwell joined the BBC in 1963 after serving four years as a design and development engineer in industry. Most of his time in the BBC has been spent in the studio engineering department at the Television Centre in West London where he worked as an engineer and, more recently, as a technical writer. He became Research Author at the BBC's Research Department last year.

Tests on digital four-phase d.p.s.k. technique of ransmitting additional sound information for tv stereophoney show the system to be more rugged than for either teletext or colour television pictures.

A single high-quality broadcast audio channel requires a bandwidth of at least 15kHz. Simple inear quantization of an audio ignal requires at least 13 bits per ample for acceptable broadcast quality. Near-instantaneous digial companding*, however, enables the number of transmited bits per sample to be reduced o ten with negligible degradation n quality. Assuming a 15kHz audio bandwidth, a sampling rate of about 32kHz is required to satisfy the Nyquist criterion** and thus avoid unwanted alias effects. The minimum bit-rate or a single high-quality audio channel is therefore about 320kbit/s. To this must be added he bit-rate needed to transmit additional data such as framing words, parity bits for error detecion, and the scale factor words associated with near-instantaneous companding. Two such channels, therefore require a bit-rate of something in excess of 640kbit/s.

A system has been devised based on earlier work at the BBC Research Department[2] and its outline parameters are given in Table 1. The proposed system, which is still under development, was not used in the South Wales tests, a pseudo-random binary sequence generator being used instead. However, the important factor was to test the modulation system employed and this is discussed next. The proposed system employs a bit-rate of 704kbit/s, chosen because it is a multiple (22) of the sampling frequency which could lead to simplification of the decoder, and it provides a few kbit/s spare data capacity for supplementary purposes.



Receiving, demodulating and measuring equipment inside a BBC survey vehicle.

Choice of modulation techniques

The choice of a modulation technique for any digital transmission system results from a compromise between the required bandwidth, the signal-to-noise ratio required to achieve an acceptably low received bit-error rate (this

Table 1. Proposed baseband coding for experimental digital stereo sound with terrestrial television.

Audio bandwidth	15kHz
Pre-emphasis	CCITT
Audio sampling rate	32kHz
Samples per block	32
Audio coding	14/10-bit near-instantaneous commpanding 640kbit/s
Scale factor bits	3 per block per Channel 6kbit/s
Error protection for sample words	32kbit/s
Error protection for scale factor bits	4kbit/s
Framing	8kbit/s
Available for further development	14kbit/s
Overall bit rate	704kbit/s

---

*In near-instantaneous digital companding he analogue input signal is sampled and digitally coded to an accuracy of 14 bits per sample. Only ten of these 14 bits are actually transmitted, the ten-bit 'window' moving up and down the 14-bit range according to the peak signal level occurring during a block of 32 samples. The receiver decoder is instructed on the correct placement of the 'window' by a three-bit scale factor word sent with each successive 32-sample block. By this method, low-level programme signals are transmitted with 14-bit accuracy. The accuracy progressively decreases down to ten bits per sample for the higher signal levels, but the consequently increased quantization noise is masked by the higher level of programme.

**The sampling frequency must be at least twice the highest modulating frequency.

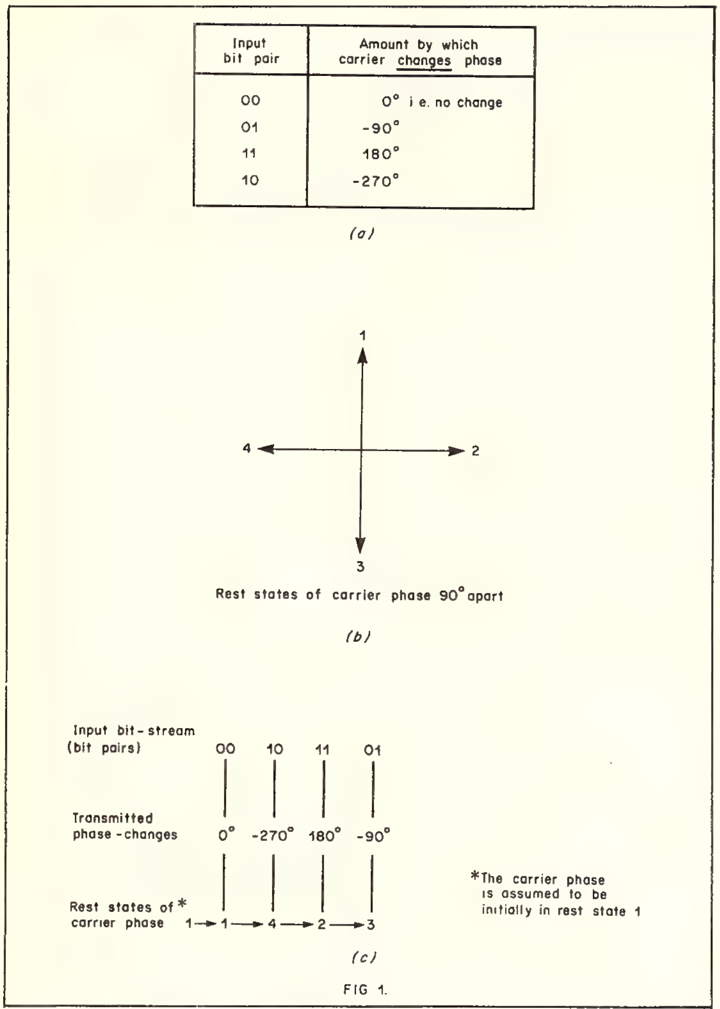

Input bit pair
Amount by which carrier changes phase
00
0° i.e. no change
01
-90°
11
180°
10
-270°
(a)
1
2
3
4
Rest states of carrier phase 90° apart
(b)
Input bit-stream (bit pairs)
00
10
11
01
Transmitted phase-changes
0°
-270°
180°
-90°
Rest states of* carrier phase
1
1
4
2
3
*The carrier phase is assumed to be initially in rest state 1
(c)

FIG 1.

Fig.1. **In the differential coding process four bit-pair combinations which modulate the carrier cause it to change phase by the amount shown in the table (a). Carrier has four possible rests state 90 apart (b). An example of carrier rest states adopted for the input bit-pair sequence 00, 10, 11 and 01 is shown in (c).**

usually determines the carrier power required), and cost. The last item is particularly important here because it is highly desirable to minimize the cost of the decoder required in domestic receivers.

The broad family of four-phase-shift keying systems offers the best compromise between the requirements above, and a particular variant known as four-phase differential or quadrature phase shift keying was chosen for the experimental system. Four-phase d.p.s.k. had been successfully used by the BBC in earlier contexts[3] so experience had already been gained in the use of this method.

Four-phase p.s.k. is a digital modulation technique in which the carrier adopts one of four possible phase states dependent on the two-bit pattern occurring at any instant, i.e. 00, 01, 11 and 10. Carrier amplitude remains constant except during phase transitions.

Simple four-phase p.s.k. requires the transmission of an additional phase reference signal for correct decoding and this can only be achieved at the expense of increased carrier power or bandwidth, neither of which is desirable. However, if the p.s.k. signal is *differentially* coded (d.p.s.k.), no additional information is required. Instead, the transmitted message is coded into carrier phase *changes* between one bit pair and the next, which the decoder does not need a phase reference to detect, Fig.1. Briefly, the modulation system works as follows.

The changes of carrier phase which correspond to the four possible bit pairs 00, 01, 11 and 10 are respectively 0, —90, 180 and —270°, Fig.1(a). The carrier phase itself can dwell in one of four rest states 90° apart, as depicted in (b). An input bit-pair shifts the carrier phase into a different rest state by the amount assigned to that particular pair. The transmitted phase changes and subsequent carrier rest states for the input bit-pair sequence 00, 10, 11 and 01 are illustrated in (c).

Choice of second sound carrier

The relative levels of the vision and sound carriers, and the frequency-spacing between the main and second sound carriers, have to be chosen to give good compatibility with existing receivers, whereby interference to the picture or main sound channel is kept to a minimum. The frequency and level of th second sound carrier must also b chosen so that the digital system works reliably throughout th service area of normal television reception. A third requirement is that the second sound carrie must not interfer with transmitters operating on adjacent television channels. The first and third requirements have been investigated in the laboratory, and the second during the field tests in South Wales. Inevitably, these requirements conflict and a compromise has had to be sought.

Theory and laboratory tests indicate that, to avoid interference to or from the main frequency-modulated sound signal the additional digitally-modulated sound carrier woudl need to be spaces 6.5MHz or more above the vision carier (i.e. 0.5MHz above the rest frequency of the main sound signal), and at an amplitude of between 20 to 25dB below it.* This is a larger frequency spacing than that used in the earlier BBC tests on the analogue two-carrier system, where a spacing of about 6.3MHz was best, because of the greater bandwidth (about 700kHz) of the digitally modulated signal compared with that of the f.m. signal.

The upper limit on the spacing of the second carrier from the vision carier was determined by adjacent-channel interference, both from the viewpoint of interference from the digitally modulated signal into the vestigial sideband of the upper adjacent channel, and vice versa.

Laboratory tests indicate that with the second sound carrier at a level of 20dB below the vision carrier level, interference from the digitally modulated second sound carrier into the upper adjacent channel is not a problem and complies with the CCIR recommended protection ratio. In fact the main sound carrier is the limiting factor for interference into the upper adjacent channel; this remains true even when the main sound carrier is reduced by 3 to 10dB below the vision carrier. Interference from the upper adjacent channel into the digital sound channel seems more likely because the CCIR recommended protection ratio in this direction is much more tolerant.

Any interference to the digital sound channel from the vestigal sidebands of the upper adjacent channel vision signal is picture dependent, which meant detailed

Table 2. Modulation system for experimental digital stereo sound with terrestrial television.

Frequency of second sound carrier	**6.55MHz above vision carrier**
Level of second sound carrier	**—20dB with respect to peak vision carrier**
Modulation of the second sound carrier	**4-phase d.p.s.k. at 704kbit/s**
Overall bandwidth (to —30dB) of transmitted d.p.s.k. signal	**700kHz**
Level of main sound carrier	**—10dB with respect to peak vision carrier**

studies of the power-density spectrum with a variety of picture signals. As expected from the vestigial sideband shaping, the power density spectrum falling into the digital channel is triangular, power-density decreasing with increasing spacing from the interfering vision carrier. This indicates that the frequency of the second sound carrier should be kept as close as possible to that of its parent vision carrier.

These conflicting requirements lead to a frequency spacing for the digital sound channel of 6.55MHz above the wanted vision carrier, i.e. 0.55MHz above the main f.m. sound carrier, Fig.2.

Parameters of the modulation system adopted fo the experimental equipment are given in Table 2.

Conclusions

The South Wales tests show that the experimental digital system is adequately resistant to impairments to digital sound signal reception arising from low field strength, multipath propagation, ignition interference, and distortions in a long chain of transposers.

The results clearly show that when receiving low field-strength signals directly from the main transmitter (at Wenvoe) the digital sound signal will not, on average, fail before the picture became unacceptably noisy; when receiving signals via a redbroadcast relay station (transposer) the average failure point occurring at a field strength well below the nominal service area limits for Band IV and V transmissions. The system is more rugged than either colour television pictures or teletext with regard to multipath propagation effects (ghosting).

In March, with Home Office agreement, the BBC conducted similar tests from the BBC2 transmitter at Crystal Palace, to confirm that the experimental system is compatible with the widest possible range of domestic receivers. In May, test transmissions were made of a television programme with stereophonic sound using the experimental system described. The results of both series of tests are very encouraging; the BBC is presently having discussions with the IBA and the receiver industry to establish an agreed UK Standard.

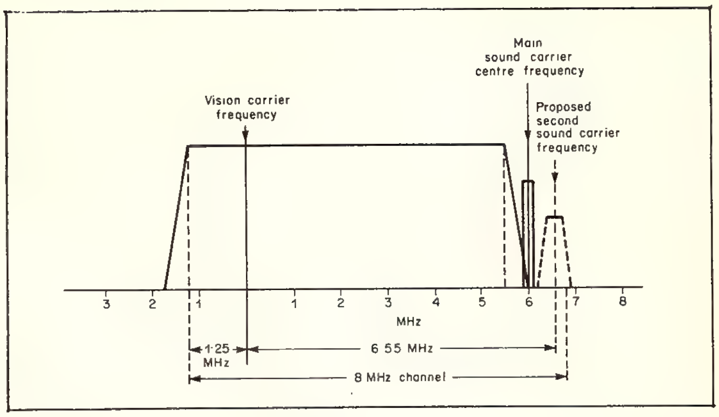

Main sound carrier centre frequency
Vision carrier frequency
Proposed second sound carrier frequency
3
2
1
1
2
3
4
5
6
7
8
MHz
1·25 MHz
6 55 MHz
8 MHz channel

Fig.2. **Frequency bands occupied by the colour picture components and sound signal of one television channel with the proposed digital sound signal added.**

Background to BBC experiments

For many years there has been interest in the possibility of adding stereophonic sound to existing television services and the BBC has investigated a number of possible methods. In all cases an additional sound signal is required to carry the stereo information and, in some cases, the additional signal is suitable for the transmission of two independent sound signals as may be required, for example, to provide a bilingual service. Methods investigated include the pilot-tone system as used for stereo radio broadcasting in the UK, the Japanese f.m.-f.m. system and the German two-carrier system, all of which employ an analogue second sound signal; and digital sound similar to that proposed for direct broadcasting by satellite television.

The first two methods have certain limitations in this context and were not pursued as serious contenders. The German method, (*WW* November 1981, Page 40) in use on a limited basis in that country, appeared more promising and engineers at the BBC Research Department devised a variant of this method adapted to the PAL System I as used in the UK.

Toward the end of 1982, the BBC conducted over-air compatibility tests of this variant from the BBC transmitter at Crystal Palace outside normal broadcasting hours. The tests indicated that the system was only marginally compatible; interference between the additional sound carrier and the main sound carrier gave rise to picture patterning, which, to avoid, required reduction of the main sound carrier. However, reduction of the main sound carier to 13dB below the vision carrier as in Germany caused increased buzz-on-sound in some existing receivers.

During the period that various options for analogue stereo sound with television were being assessed, the status of digital techniques in domestic equipment had changed considerably and consumer products, such as the digital audio disc with its attendant high quality sound, had become available. Also, the BBC proposes using an internationally agreed system of digitally coded sound for d.b.s. These advances led to the consideration of a digitally modulated second sound carrier to convey the stereo signal.

A digitally-coded signal is more rugged than its analogue counterpart and may therefore be transmitted at a lower level. This reduces the level of any interference between the main sound carrier and the added digitally-modulated carrier. Also, because of the more noise-like nature of a digital signal, the visibility of any interference patterns is reduced further, which enables the main sound carrier to be maintained at or near its full level, avoiding the increased buzz-on-sound problem found with the analogue two-carrier system.

A thorough investigation of the digital option carried out at the Research Department led to over-air tests of an experimental system, conducted outside normal broadcasting hours from the BBC2 transmitter at Wenvoe in South Wales and its associated rebroadcast relay stations during the autumn of 1983 [ref.1]. This particular area was chosen because the terrain is hilly and multipath propagation of normal television signals very evident. The area contains a large concentration of rebroadcast relay stations which enabled assessment of the digital sound signal when subjected to the cumulative effects of distortions in a long chain of such stations.

This article discusses the reasons behind the choice of parameters used for the experimental systems, together with a summary of the test results.

References

1. S.R. Ely. 1983. Experimental Digital Stereo Sound with Terrestrial Televison : field-test from Wenvoe, October, 1983. BBC Research Department Report RD1983/19.
2. D.F. Reid and N.H.C. Gilchrist. 1977. Experimental 704kbit/s Multiplex Equipment for two 15kHz Sound Channels. BBC Research Department Report RD1977/38.
3. M. J. Kallaway. 1976. Experimental Four-phase Differential-phase-shift-keying System to carry two High-quality Digital Sound Signals. BBC Research Department Report RD1976/20.

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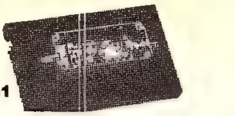
*The vision carrier level is taken as the peak vision carrier power at the tips of the sync pulses, and the levels of the main and second sound carriers refer to the respective levels of the unmodulated carriers.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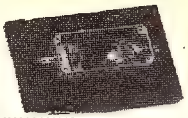
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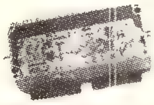
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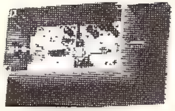
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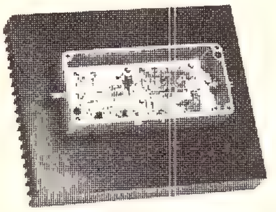
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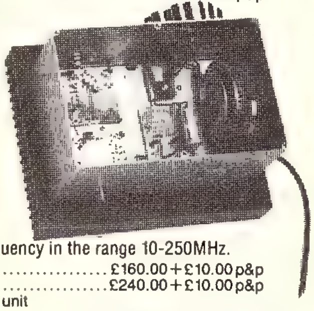
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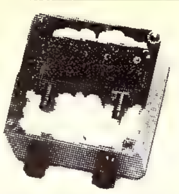
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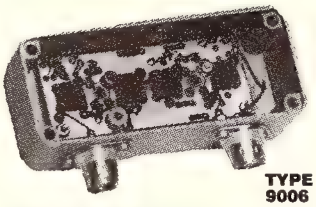
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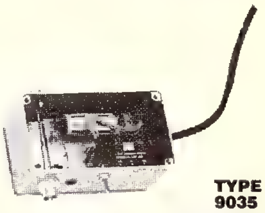
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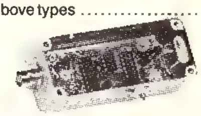
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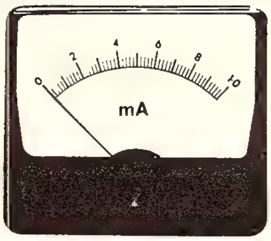

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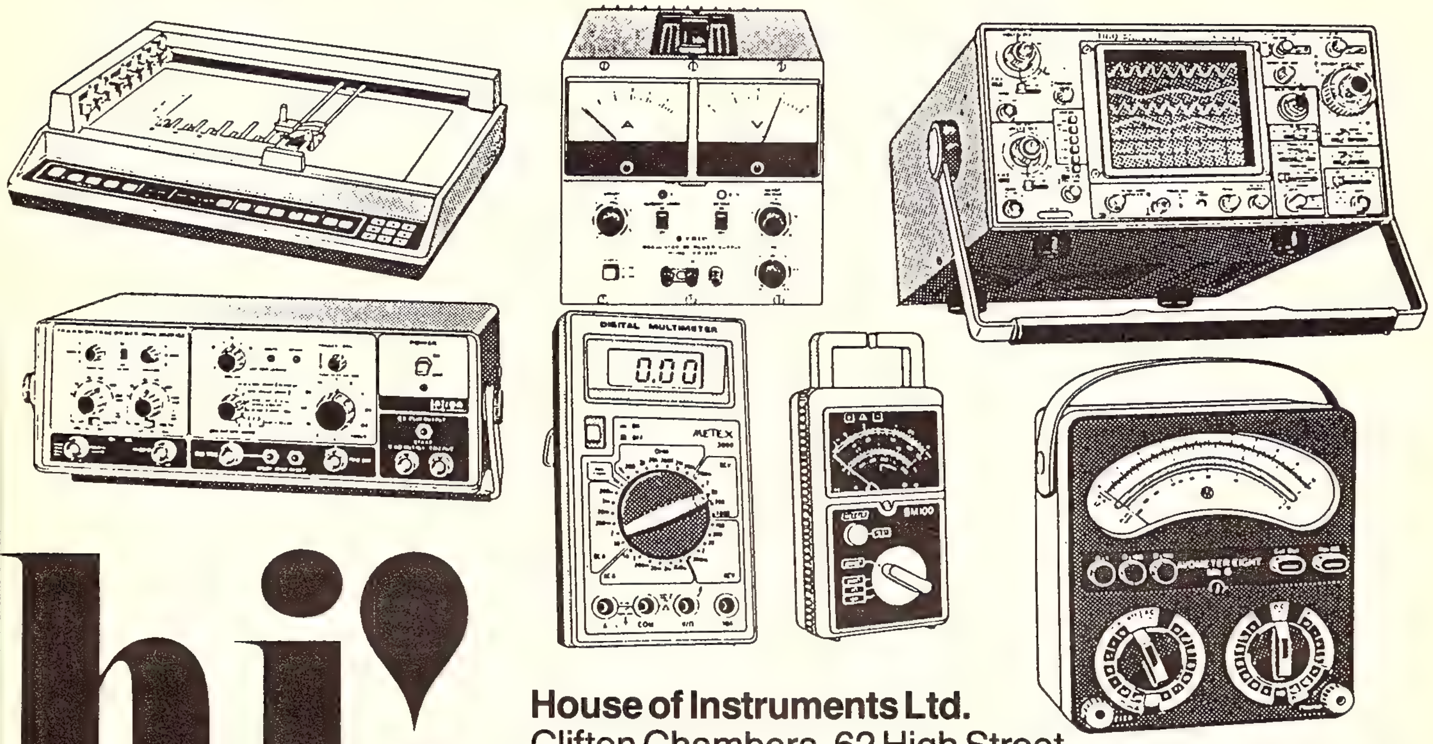

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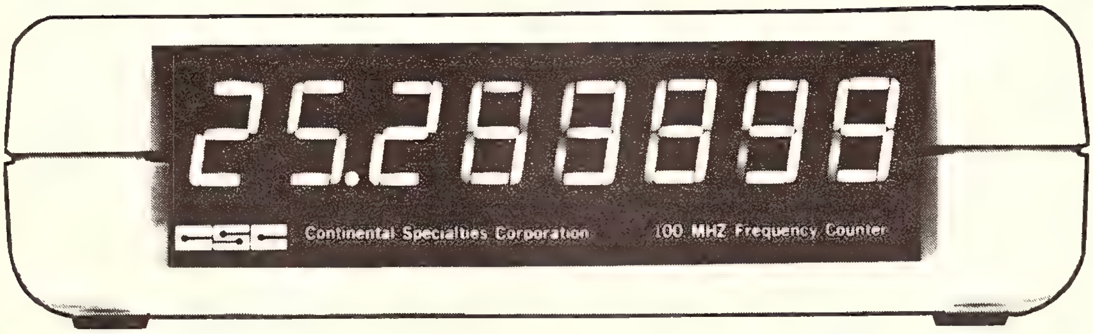
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CIRCLE 26 FOR FURTHER DETAILS.

by R. M. Adelson

Music keys for the BBC microcomputer

Using the computer's sound unit or external generators, this economical polyphonic keyboard interface makes a musical instrument and an educational tool for storage, analysis and display of music.

Ronald Adelson graduated in engineering from Cambridge University in 1956. After a spell in industrial electronics he entered the field of operational research which has been his principal occupation since. However he has kept up an active interest in electronics, especially where it impinges on his interests as a musician (actually he plays the bassoon — perhaps not quite the same thing!). He joined the Operational Research Department of Lancaster University in 1967. A recent initiative by the Music Department at Lancaster is currently enabling him to spend some of his time putting his technical skills to work.

Potential of the microcomputer as a tool for teaching, editing and perhaps even composing music is great, as the amount of music-related software currently available will testify. This software however suffers from one serious drawback — the means of entering musical information into the computer. These means include the computer's typewriter-layout keyboard and sometimes games paddles or joysticks but all are clumsy, slow and error prone which is a great discouragement to the musician (as opposed to the computer enthusiast) attempting to use the computer creatively.

There are systems that include the natural input device for a musician — a music keyboard — but they are mainly intended for computer-based synthesizer applications. Best known of these are probably the Fairlight Computer Musical Instrument costing around £20 000 and the Alpha Syntauri add-on for the Apple computer costing around £2 500. The Alpha Syntauri is intended for use as a synthesizer but there is now some elementary teaching software available for use with it. Some other (mainly American) music teaching systems were recently reviewed by David Ellis*.

Lancaster University's music department is studying possible uses of microcomputers in aspects of its work including the training of musicians, music editing and research into music analysis. We felt from the outset that a 'musician friendly' input device was essential for acceptance by potential users and given the cost of commercial systems — not to mention their shortcomings — we decided to develop a straightforward and cheap keyboard interface for the BBC microcomputer. The outcome is a keyboard and interface costing around £50 in components and drawing about 60mA from the computer's 5V supply, which hasn't caused problems even while two disc drives are powered from the same source.

Design considerations

Synthesizer applications were not considered a prime objective although the design can be used to play the computer's own sound generator or external units. No attempt was made to make the keyboard touch sensitive to measure the speed of key depression; simple on/off key switches will suffice. Uses envisaged for the interface suggested that it should be fully polyphonic, i.e. should accept chords and should not be restricted to the one-note-at-a-time characteristic of typewriter-style keyboards designed for computer input. Finally, rapid response was required and in some circumstances the computer might be processing input

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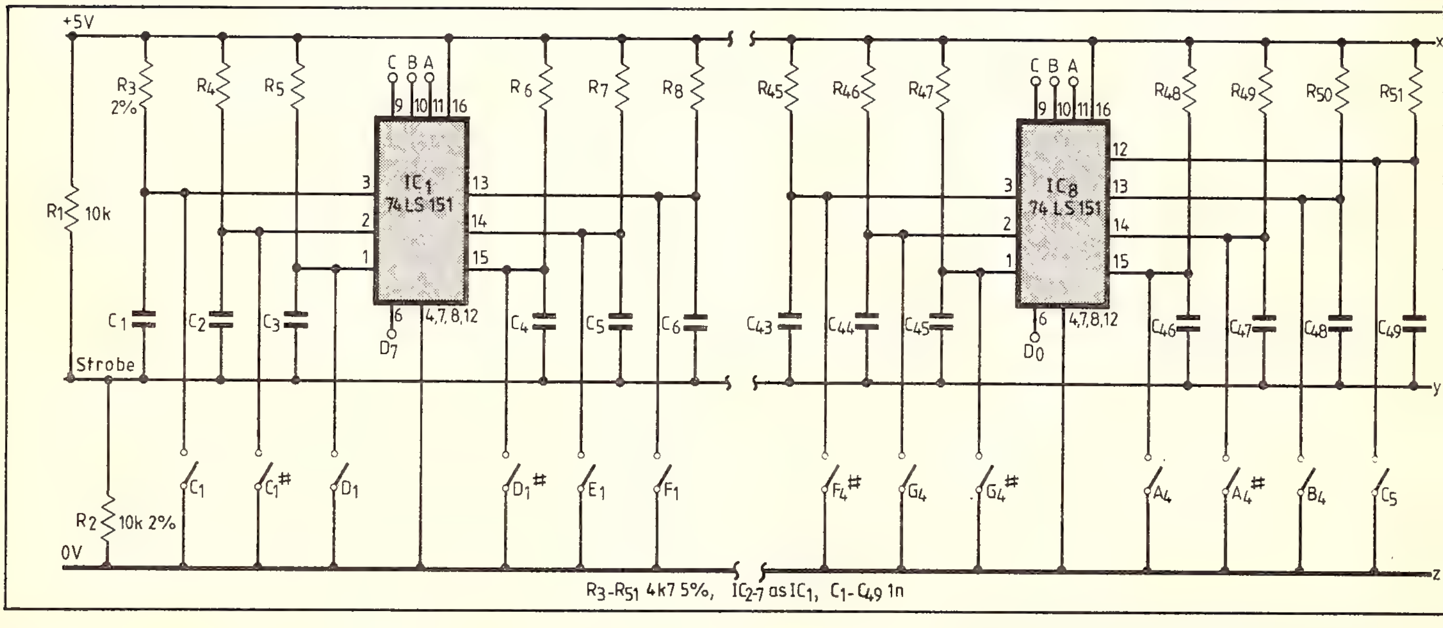
*David Ellis, CAMI — Some educational music programs. *Electronics and Music Maker*, Oct. 1983.



R3-R51 4k7 5%, IC2-7 as IC1, C1-C49 1n

Fig. 2. Circuit of the music-keyboard interface. Whenever strobe voltage goes outside the narrow window defined by R_{54-56}, dual comparator IC_9 generates an interrupt at CB_1. The computer then responds by reading the inputs of IC_{1-8}, then clocking them on using CB_2 on IC_{10} until the whole keyboard status has been read.

information in real time, suggesting that time should not be wasted by scanning the keyboard unnecessarily.

These conditions were met by making the system interrupt driven and bit mapped. This means that any change in keyboard status due to a key being pressed or released produces an interrupt signal causing the computer to read the status of all the notes on the keyboard. On reading the keyboard, the computer stores a bit-mapped image (zero for an unpressed key, one for a pressed key) of the current keyboard status for subsequent analysis, display, sound generation, etc.

Hardware

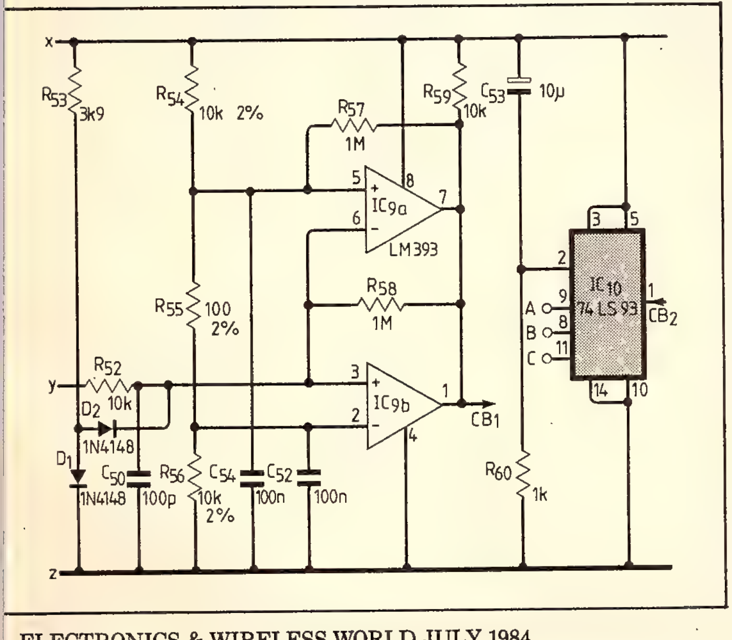
A four octave C-C (49 note) keyboard is used. Initially, the 49th note proved a minor nuisance since 48 notes can be neatly mapped into six bytes. However, in the final design it turned out to be convenient to read the keyboard in eight bytes so the system can accommodate a five-octave keyboard. One byte is used to check that spurious noise pulses have not sent the interface byte counter out of step with the reading software.

Keyboard and key switches used are those sold by Maplin Electronic Supplies as the basis of their 'Spectrum Synthesizer' (no connection with the well known microcomputer). The key switches are unusual in that they are simply coiled springs soldered to a p.c.b. at one end and touching a bus bar on the p.c.b. at the other end when the key is pressed (the p.c.b. is also supplied). This seemingly effective keyboard is easy to assemble and much cheaper than using conventional organ key switches. Some initial problems were experienced due to key bounce caused by spring vibration but these were solved by inserting lengths of soft foam plastic at the edge of the p.c.b. where the switches are soldered to damp the vibrations.

The BBC microcomputer user port is connected to the B lines of a 6522 versatile interface adaptor, v.i.a. It carries eight data lines, D_{0-7}, two handshake lines, $CB_{1,2}$, a number of ground lines and the computer 5V supply. Through programming, the v.i.a. can be made to generate an interrupt signal when CB_1 changes from high to low or alternatively low to high — but not both. For the keyboard, a response is required when any key is pressed, or released, and even if a number of other keys are already held down, so a means producing a suitable interrupt signal is needed.

Figure 1 shows basic key connections in which two equal resistors, $R_{1,2}$, establish a steady-state voltage of 2.5 on the strobe rail. Each key switch is conncted to a network made up of R_x and C_x. Initially, C_x has a potential difference of 2.5V across it (lower plate 5V, upper plate 2.5V). When the switch is closed, the lower plate potential falls initially by 5V and as the capacitor's charge cannot change instantaneously, so does the upper plate's potential i.e., the strobe potential drops to -2.5V.

In due course, C_x discharges through R_2 then recharges with reverse polarity through R_1 and the strobe returns to 2.5V. When the switch is opened, C_x tries to discharge through $R_{1,2}$ and R_x and in doing so pulls the strobe line above 2.5V by an amount depending on the values of the resistors. The capacitor now discharges and recharges to the original steady-state voltage through R_1 and R_x, so key status can be read at point S.



If several keys are connected to the strobe rail each with their own RC networks, their behaviour will be similar but step magnitudes and associated time constants will depend on how many keys are pressed. For example, if 48 keys are pressed — a tricky feat even using arms instead of hands — pressing the 49th key places the last C_x in parallel with the 48 others and limits the step size to about 100mV. However, as long as the system can detect the smallest possible step and react to the minimum time constant while the maximum time constant is short enough to ensure that recovery occurs before one has a chance to press the next key, all is well. Component values shown allow the keyboard to respond to chords of any number of notes that I have managed to reach over and to trills and glissandi without problem.

Negative-going interrupts can be produced by taking the strobe line to the non-inverting input of a comparator whose input is biased just below 2.5V so that it responds only to negative-going pulses, and to the inverting input of a further comparator, whose non-inverting input is at just above 2.5V, which responds only to positive-going pulses. The LM393 dual comparator is ideal for this purpose since it works with a 5V supply and has open-collector outputs which can be wired together to produce OR gating.

Figure 2 is the final circuit. Resistors $R_{1,2}$ provide bias for the strobe rail and R_{3-51} and C_{1-49} are R_x and C_x for each key, Fig.1. Resistors R_{54-56} provide bias for the comparators, IC_9. Resistor R_{59} forms collector load and resistors $R_{57,58}$ provide some hysteresis — usually a good policy when using comparators to improve noise immunity and switching times and to reduce tendency to spurious oscillations. The input voltage on IC_9 must not be allowed to fall below ground and it can be seen from Fig.1 that the strobe rail can do this — hence

Continued on page 29

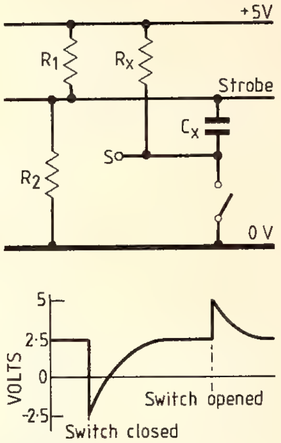
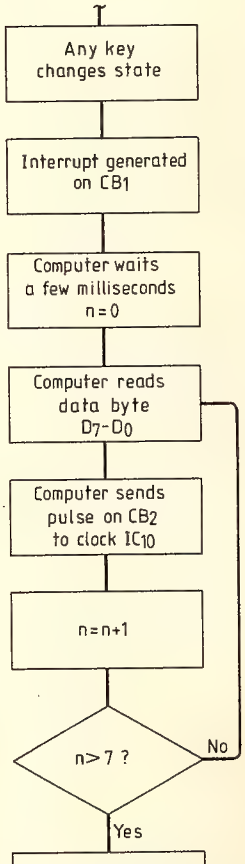


Fig. 1. Outline of the keyboard's interrupt generator. Closing or opening the switch causes the voltage on the strobe rail to act as shown. Each pulse causes an interrupt.


Any key changes state
Interrupt generated on CB1
Computer waits a few milliseconds n=0
Computer reads data byte D7-D0
Computer sends pulse on CB2 to clock IC10
n=n+1
n>7 ?
No
Yes
Terminate interrupt

At switch on, the counter is set to zero and its synchronism is checked each time the keyboard is read. The delay allows for key bounce and for the fact that is impossible to play all the notes of a chord simultaneously.

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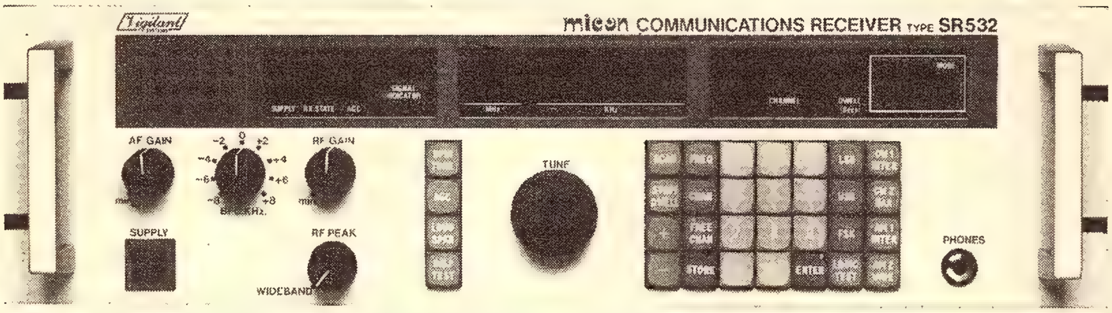

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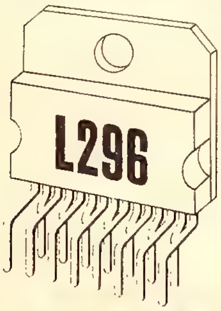

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Television reception with papaya tree antenna

Novel technique couples r.f. energy from vegetation canopy to receive tv signals.

by S.P. Kosta
K.N. Shamanna
R. Bhawani Shanker
K.S. Dayashankara
B. Rudralingappa
V.R. Katti
Y.P. Kosta

Back in 1979 we conceived of using green vegetation canopy as an r.f. antenna and conducted feasibility studies with a live cypress plant and freshly cut date palm leaf branch at 1000MHz to successfully demonstrate it[1]. Later[2], we conducted experimental studies to use vegetation canopy (leaves and branches of gulmohr, canna, bottle brush, coconut, date palm, fern, etc) as electromagnetic antennae structures at microwave frequencies. These studies reveal that certain geometrically-shaped vegetation, due to water and chlorophyll content vis-a-vis their dynamic complex dielectric properties can sustain, propagate and radiate electromagnetic waves from their structure if suitably excited. A gain varying from 2 to 5dB over an exciter probe antenna from selected vegetation canopies at 1000, 3000 and 4000MHz has been achieved with satisfactory impedance-matching characteristics. (The radiation pattern of the exciter probe antenna be shaped with increased its gain axially when it excited an e.m. wave on vegetation cover structure.) A range of branches from a single tree branch to a bunch of a few branches (kept in a plastics cone to maintain a dielectric-rod antenna configuration of the bunch) were used to achieve better radiation pattern characteristics with a gain of around 5dB over that of the exciter probe antenna.

In all these studies a probe helix at the end of a vegetation branch was used to excite an e.m. wave on the vegetation structure. The radiation characteristics so observed were found to remain so long as the vegetation structure is fresh, and start to deteriorate with increase in dryness.

We further reported[3] experimental studies to receive Band 3 television signals from the Bangalore transmitter (radiating 1kW) by using freshly-cut date palm and coconut branches, of length 1.5 and 3 metres respectively. The vegetation cover with reasonably good signal-to-noise ratio. A new simple method to tap the r.f. energy captured by the leaves branch was reported at the same time.

And most recently, we received signals from the Bangalore tv transmitter using a few live papaya trees (one at a time only) of height around 3 to 5m in length and located firstly at 12km and later 25km away from the transmitting tower.

Experimental set up

In this last experiment a few papaya trees (used one at a time), of height around 3 to 5m were

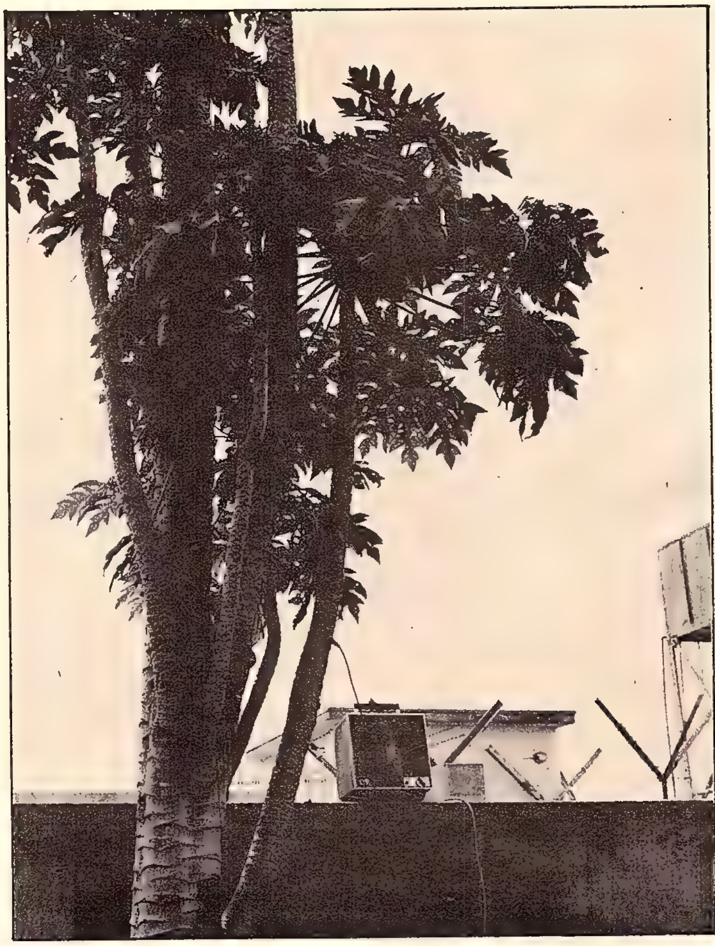


Fig.1. **Field receiving site**

Dr Shiv Prasad Kosta graduated from Jabalpur University and took his Ph.D. in Telecom engineering in 1969 at the same university.

Dr Kosta is a specialist on antenna and transmission line systems and has more than 120 research and technical papers to his credit. He takes keen interest in basic research problems relating to electromagnetics, antenna and microwaves and has guided students for M.Tech and Ph.D. degrees. Recently, Dr Kosta conceived of using trees and salt solutions as tv and radio antennas for very high and microwave frequencies.

Presently, Dr Kosta is working as head of systems integration, at the ground checkout and test division of ISRO Satellite Centre, Pennya, Bangalore.

The authors are with ISRO Satellite Centre, Bangalore, India, except S.P. Kosta who is studying at the National College, Jayanagar, Bangalore.

Fig.2. **Probe coupling configuration**

located to receive line-of-sight signals at a distance varying from 12 to 25km from radiating tv tower were used to receive colour, as well as black & white signals. A flexible coaxial cable (RG-58A/U) tapped r.f. energy from the appropriately selected places of the tree. The inner conductor of the BNC connector (EMRI-506, projecting by around 3mm) was pierced through first into the trunk and then at the end point of the stem supporting the green leaf of the tree (Fig. 1).

The maximum signal tapping point was found after many trials, from which we found that the piercing end of the inner conductor should touch the moist/wet portions of the tree (xylem, phloem, chloren chyma, etc). The other end of the coaxial cable was connected to a Sony portable receiver model CVM-111E. The BNC connector is not necessary to tap the r.f. energy, Fig. 2. A bare sharpened inner conductor end of RG-58A/U cable itself should be used in practice to economically receive television signals.

Observations

The signal received with the probe antenna alone at the height of the tapping point was very hazy (unreadable) at 12km distance and, practically, identification of the picture wasn't possible, Fig. 3. Further, no signal was received by the probe alone at 25km distance.

The signals received from the papaya tree trunk, its one green leaf and the dipole antenna at 12km and 25km distance, were of good readable quality. The v.s.w.r. under best conditions of reception was around 1.5. Only the leaves pointing clearly toward the tv transmitting tower without obstruction received good television pictures. To achieve higher gain (better s/n ratio of the received tv picture), standard antenna array techniques using a few suitably located Papaya trees or a few suitably oriented leaves need to be studied in depth.

Under average conditions (slow breeze and feeble rain) the observed tv picture quality was fairly satisfactory.

Theoretical model

To a first order of approximation one may simulate either

- suitable symmetrical and geometrically-shaped freshly-cut or live vegetation branch or a bunch of branches (like fern, date palm, bottle brush) as a standard well-known dielectric rod antenna configuration; or
- papaya, coconut, banana-type live branch leaf as a thin dielectric sheet aperture antenna.

The exact constitutive parameters of a green leaf are not well-known[4]. Because of the very large static dielectric constant of water one can well expect that the moisture content of the leaf will have a predominating influence. A reasonable estimate of the complex dielectric constant of green foliage (Du and Peake[4]) can be made from the following equation:

$$\varepsilon - j\frac{g}{\omega\varepsilon_0} = G\left(5 + \frac{75}{1+\frac{f}{f_0}}\right) + G\frac{g_e}{j\omega\varepsilon_0}$$

where g_e the ionic conductivity due to dissolved salts of the fluid in the leaf, G is the fraction of water content, f_0 is 16GHz, and ε_0 have the usual meanings, and the conductivity of the dissolved salt may vary widely but is assumed here to be 0.2 to 0.4 × 10^{-4}mho/m. Further, the effective relative dielectric constant of the medium can also be written as

$$\varepsilon_x = \varepsilon_j + \frac{g_j}{j\omega\varepsilon_0}$$

where ε_x is the effective dielectric constant, and g_j the effective conductivity.

Du and Peake[4] measured values of the relative dielectric constant ($\varepsilon \approx 1.01$ to 1.04) and effective conductivity ($g_j \approx 0.2$ to 0.4 × 10^{-4}mho/m) of the green leaves with varying percentage of water content (10 to 50%) and the volume concentration of the leaves (in the range of 0.0003 to 0.001) at v.h.f. They have also found that dielectric constant is nearly independent of frequency in the v.h.f. band. Spence and Heisler[5] have reported dielectric constant of jungle environment as $\varepsilon_j = 1.02$ and conductivity $g_j \approx 10^{-4}$mho/m. It is also known that

Continued on page 29

REFERENCES

1. S.P. Kosta, *et al*, Cypress plant as r.f. antenna, *Frequenz*, April 1979, pp.117/8. S.P. Kosta, *et al*, Date palm tree branches as antenna structure *Nachrichten Technische Zeitschrift* (NTZ) April 1979, p. 236.

2. S.P. Kosta, *et al*, Gulmohr vegetation canopy as antenna structure. Communicated to IEEE Transactions on Antennas and Propagation, paper C-013 June 1983.

3. S.P. Kosta, *et al*, Coconut tree branch — nature's television antenna. Communicated to Proc. IEEE, September 1983.

4. Li-Jen Du and W.H. Peake, Rayleigh scattering from leaves *Proc. IEEE*, June 1969, pp. 1227—9.

5. J.E. Spence and K.G. Heisler Jr., Radio propagation loss in a tropical jungle. Abstracts of URSI 1967 Fall Meeting, University of Michigan, Ann Arbor.

6. Jasik, H. Antenna Engineering Handbook. McGraw-Hill, New York, 1961.

Variable-speed video playback

by J. R. Watkinson, M.Sc., B.Sc.

Using C-format video recorders over a wide speed range. Discussion continues with a description of the effect of the recording process on video waveforms.

At +2× and at 0, a single-track jump is required every drum evolution, whereas at -1× and +3×, a two-track jump is equired. At intermediate peeds, a sequence of single and wo-track jumps is made. A ingle-track jump will always be made, but if the bimorph displacement exceeds one track at he end of a field, a two-track ump is needed. This process can be extrapolated up to any speed as necessary until the travel of the bimorph cannot cater for complete tracks. In this extreme case, a maximum size jump will take place whenever the travel limit is approached.

The head jump must take place during the vertical interval n order that it shall not occur in a visible part of the picture. There s, however, a further difficulty. n C-format, vertical-interval storage is optional and vertical detection is done by locating the equalising pulses which are at the end of the main field track. These pulses are relatively narrow, and could be missed in the case of dropout. They are thus predicted and validated by counting lines along the field track. The 3½ line timing shift between adjacent fields has been mentioned: if a ump takes place, this shift has to be taken into account in order to ocate the equalising pulses correctly.

When the tape speed is varied, the head-to-tape speed changes, causing the off-tape H sync. pulses to change frequency. As the tape-head contact is not continuous, the machine has to maintain sync. from track to track by counting extrapolated H sync. pulses at the same frequency as they are coming off the tape. A circuit is incorporated which measures the off-tape line period in cycles of a reference clock, and which can generate H pulses separated by that period during the vertical interval. By counting these H pulses, and modifying the count by $3\frac{1}{2}$ lines for every track jumped, the machine can always know where it is in a field, and generate convincing vertical pulses which it has not played back. The drum servo will use these corrected vertical signals in order to maintain correct drum phase in the presence of head jumping. It is important that the off-tape field rate should always equal reference field rate: the reason for this will become clear when the timebase corrector is discussed.

Effect of the v.t.r. on video waveform

Mixing and editing in PAL video is only possible provided that all sources are synchronised to within about 5 degrees of subcarrier, which is approximately 3 nano seconds. A field in PAL has a duration of 20 milliseconds, so the stability demanded is:

$$\frac{3\times10^{-9}}{20\times10^{-3}}\times100\%=0.000015\%$$

As no mechanism can approach such a tolerance, timebase correction is mandatory even at normal speed.

Video tape, like all magnetic tape, has a plastics backing, which has a relatively high temperature-coefficient of linear expansion, and can also change its dimensions as a function of ambient humidity. It is also flexible. The length of a field track on the tape can be altered by temperature, humidity or tension changes, and timing errors will be caused.

When tapes are interchanged between machines, mechanical tolerances on drum diameter and tape tension will change playback timing. The impact of the rotating heads striking the tape and leaving again creates shock waves which travel along the tape, causing jitter.

Where portable recorders are carried whilst recording, inertial effects can cause timing shifts of several lines. The drum attempts to rotate at constant speed with respect to the earth, owing to its inertia, and if the v.t.r. is turned about the drum axis, the drum phase will change until the drum servo can correct it. This is often erroneously referred to as 'gyroscopic error'.

Video tape is also subject to dropout, where the playback r.f. level is too low to resolve the frequency. Although the mechanism of dropout cannot in itself change

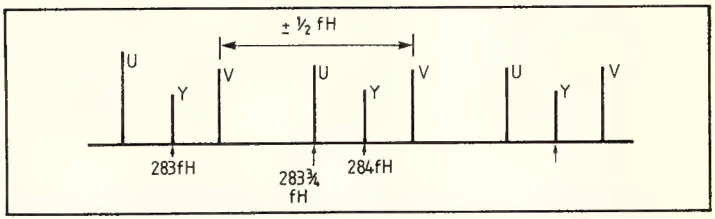
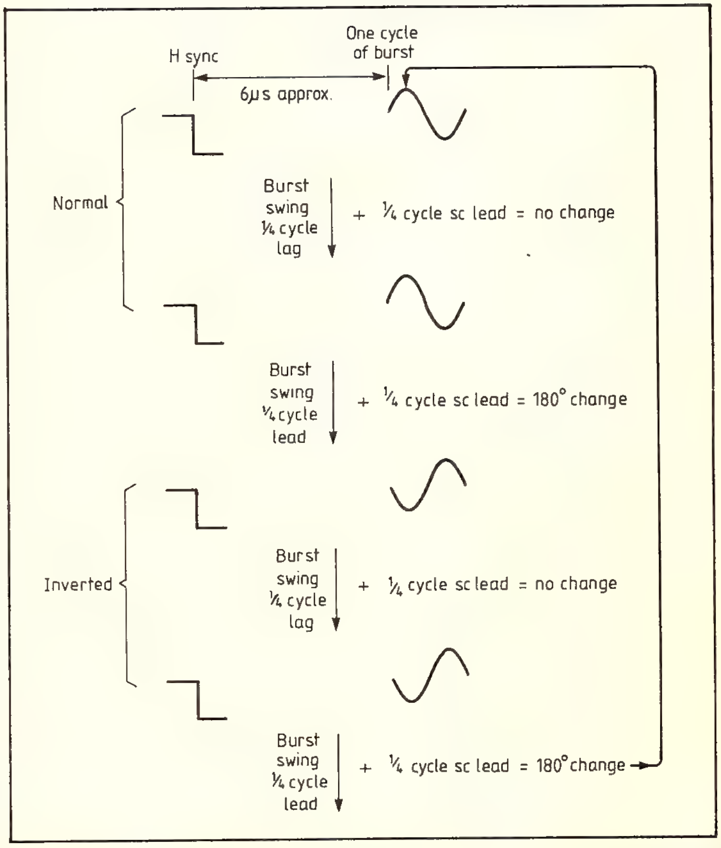


Fig. 10. **In PAL, subcarrier must be at odd multiple of one quarter line rate for U and V spectral peaks to interleave with luminance (Y). Unlike NTSC, there is no dominant component at $1/2f_H$ points.**

Fig. 11. **Quarter-cycle subcarrier/H relationship and burst swing combine to give four-line sequence—normal and inverted pairs which is not absolutely defined.**



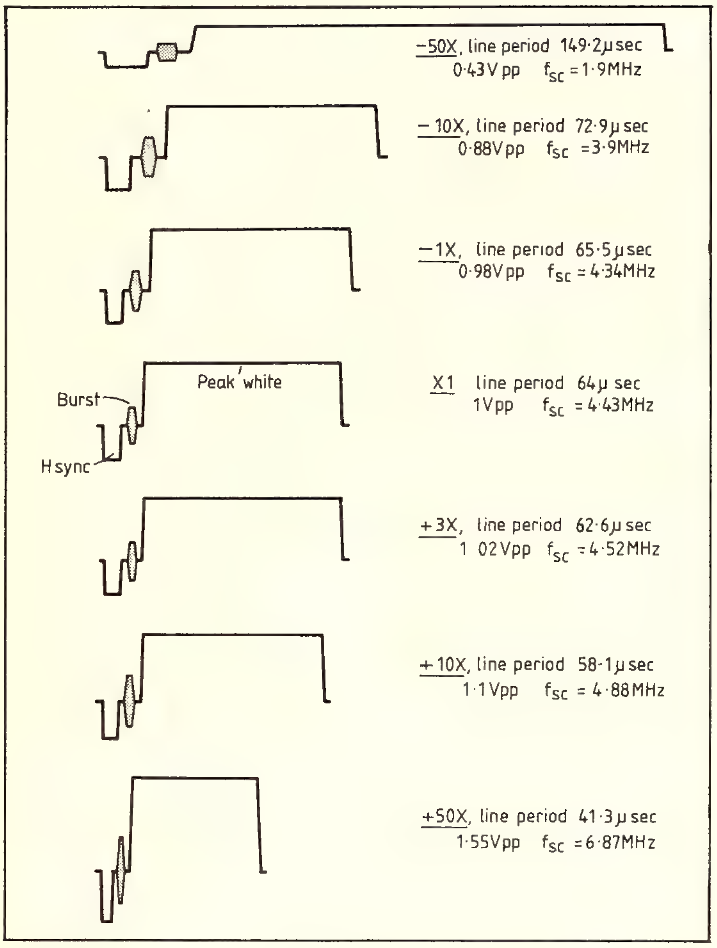

−50X, line period 149·2μsec
0·43Vpp f_{sc} = 1·9MHz
−10X, line period 72·9μsec
0·88Vpp f_{sc} = 3·9MHz
−1X, line period 65·5μsec
0·98Vpp f_{sc} = 4·34MHz
Burst
Peak white
H sync
X1 line period 64μ sec
1Vpp f_{sc} = 4·43MHz
+3X, line period 62·6μsec
1 02Vpp f_{sc} = 4·52MHz
+10X, line period 58·1μsec
1·1Vpp f_{sc} = 4·88MHz
+50X, line period 41·3μsec
1·55Vpp f_{sc} = 6·87MHz

Table 1

video timing, the consequence of dropout can. For example, the destruction of a burst by dropout renders the following chroma information meaningless, since the timing of the suppressed carrier is lost. Dropout compensation is thus a major function of timebase correctors.

If the variable-speed playback is employed, the effect is to change the line period from the standard 64 microseconds. It is possible to calculate the line period for any speed. As the track angle in C-format is so small, the error caused by assuming it is zero is of the order of 0.1%, which can be neglected. The line period in inversely proportional to the head/tape speed. At ×1 forward, the tape speed is 239. 8mm/s, and the head to tape speed is 21.39m/s. If the tape is run at +2× normal speed, the head/tape speed will now be 21.39 + 0.2398m/s and the line period will be

$$t_H = \frac{64 \times 21.39}{21.39 + 0.2398}\ \mu s = 63.29\ \mu s$$

a change of about 1.1%.

It is important to remember that, although the line period becomes smaller, the field rate remains constant owing to the constant drum speed. The visible part of the picture is thus time-compressed into a shorter part of the field period, and the interval where the head is between tracks will be extended. Owing to the horizontal alignment condition, this extension will be 3½ off-tape lines at +2X as there is a one-track jump at every drum revolution. There are normally 312½ lines in a field, but at +2× speed, an extra 3½ can be fitted into the same field period. This holds the key to a much simpler way of calculating the line period, which is

$$t_H = \frac{64 \times 312.5}{312.5 + 3.5} = 63.29\ \mu s$$

This can easily be generalised if the specific speed S is unity at normal speed.

$$t_H = \frac{64 \times 312.5}{312.5 + (S-1) \times 3.5}\ \mu s$$

This equation is to be preferred, since no approximation has been made, and no knowledge of drum dimensions or tape format is needed except the size of the video offset of 3½H. It is very easy to arrive at the equation for other standards. For example, in 525/60 NTSC C-format, the video offset is 2½H. The equation follows from that. Table 1 shows the effect of applying a variety of speeds to the equation. Interestingly, in reverse, the field tracks are stretched in time, the backwards head jumps lose 3½H for each track jumped and the vertical interval is encroached upon.

The change in head/tape speed also changes the apparent frequency range of the f.m. carrier, and consequently the levels and amplitude of the playback video. The percentage change can be derived from the equation for change in line rate, since both are controlled by the same phenomenon.

Jumping performed in variable speed causes fields to be omitted or repeated, which destroys the eight-field sequence of PAL. The recreation of the eight-field sequence, the correction of the time compression or expansion of fields, and restoration of video levels are the major additional actions of a variable speed timebase corrector.

Appendix
PAL structure

The broadcasting of colour television is done in such a way that the bandwidth of the signal is no greater than that of a monochrome signal of equal resolution, and that a monochrome receiver can display a good picture from a colour broadcast without modification. Without these constraints, NTSC could never have been introduced, since every monochrome tv set in the United States would have been made obsolete overnight by a non-compatible system.

The bandwidth constraint was achieved by choosing a subcarrier whose sidebands interleaved with those of the monochrome signal, and monochrome compatibility was achieved by encoding colour difference signals into the subcarrier which a colour receiver could use to convert the monochrome signal into a colour picture. The subcarrier would be virtually invisible to a monochrome receiver. The only problem was that the original designers of the 525/60 monochrome system had very wisely placed the sound carrier at an odd multiple of half line rate, to give maximum immunity to video sidebands. This became, however, precisely the frequency of subcarrier sidebands. A solution involving a change of sound carrier frequency would have meant re-aligning the coils in every tv set in the United States, so the only alternative was to shift the video/subcarrier spectrum by changing the entire picture rate. NTSC field rate is thus 59.94 Hz, a change of 0.1%. A direct consequence of this was the development of a drop-frame time code to permit synchronisation of this strange frequency with real time.

Experience of broadcasting NTSC led the PAL system, whose well known characteristic of reversing the sense of one of the colour-difference signals on alternate lines had some far reaching consequences. The first, and intended, consequence is that by line averaging, hue errors caused by phase errors under difficult reception conditions were converted to saturation errors, much more acceptable subjectively, and the hue control was eliminated from the receiver.

Choice of subcarrier frequency in PAL is, howerver, more complex than in NTSC because of the V switch. the effect of the V switch is to shift the V spectrum up and down by ±1/2 f_H at half-line rate. The unswitched U signal is at the centre of the ±1/2f_H swing of the V energy.

If the subcarrier (U) frequency were chosen at an odd multiple of half line rate, this would make V sidebands coincide with luminance. To interleave Y, U and V, it is mandatory that the subcarrier frequency is an odd multiple of *one quarter* line rate. The odd multiple chosen is 1135, but 1133 or 1137 would have worked just as well. Figure 10 shows that, using this frequency, perfect interleaving of Y, U and V is achieved. Note also that there is no spectral component at half line frequencies, a fundamental difference from NTSC.

The subcarrier frequency in AL is thus fixed at 283¾ times ine rate, but with offset of 25Hz, vhich causes residual ubcarrier on luminance signals o be out of phase on alternate ields, helping to make the ubcarrier invisible to the viewer.

Subcarrier frequency is lefined as

$$283\tfrac{3}{4}f_H+\tfrac{1}{2}f_V=283\tfrac{3}{4}\times 312\tfrac{1}{2}f_V+\tfrac{1}{2}f_V$$
$$=88672.375f_V$$
$$=4.43361875\,\text{MHz}$$

The V signal can only be decoded properly if the receiver knows the sense of the switch. This information is conveyed by swinging the burst phase, relative to continuous subcarrier, from line to line. A well damped phase-locked loop in the receiver will run at the average phase of successive bursts, but the sense of the phase error in the loop wil follow the burst swing and will reveal the sense of the V switch to the decoder. The swing could not be ±90°, because there would be ambiguity about the average phase. A swing of ±135° corresponds to 90° between the lines.

Spectrum interleaving demands a quarter cycle offset between subcarrier and line frequencies, a direct result of PAL V switch. Burst swing is another direct result of using V switch. The combination of these two gives some interesting results.

The quarter-cycle shift means that subcarrier phase advances by 90° from the start of one line to the next. Burst swing is also 90° from line to line, but alternately avanced and retarded. On some lines then, the 90° advance of the subcarrier cancels the 90° retarded burst, giving no change, whereas on others, the 90° subcarrier advance adds to the 90° advanced burst, causing a 180° change. The result of this is a four-line sequence, containing, relative to H pulses, two identically phased bursts, and two identically inverted bursts. Figure 11 shows these effects.

The two burst phases, normal and inverted, are determined by the state of a squarewave of 1/4 line rate. As 625 will not divide by four, it takes four frames before a given relationship between the burst phase control signal and the vertical pulse repeats. The 25Hz offset is negligible within the four-line sequence described, but it causes the four-frame sequence to contain 2500 unique lines.

This extremely long sequence must never be broken if the signal is to be broadcast, and this adds to the complexity of videotape editors and timebase correctors.

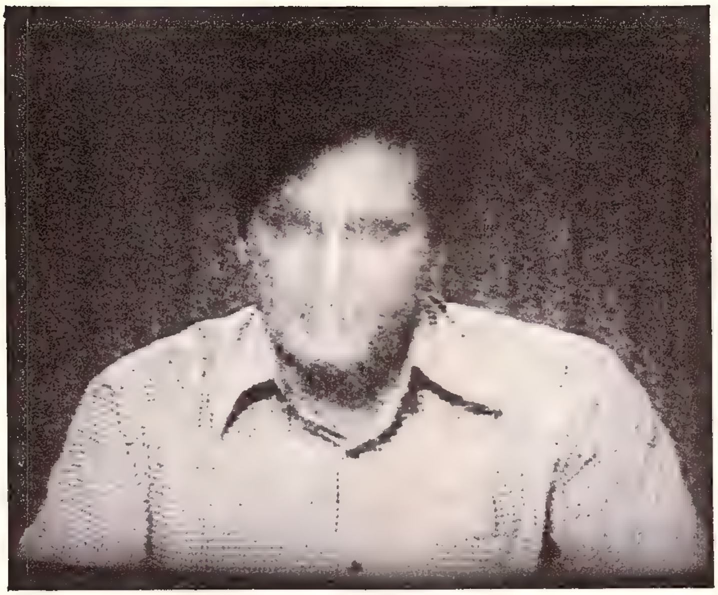


Fig.3A. **Received TV picture by probe antenna**

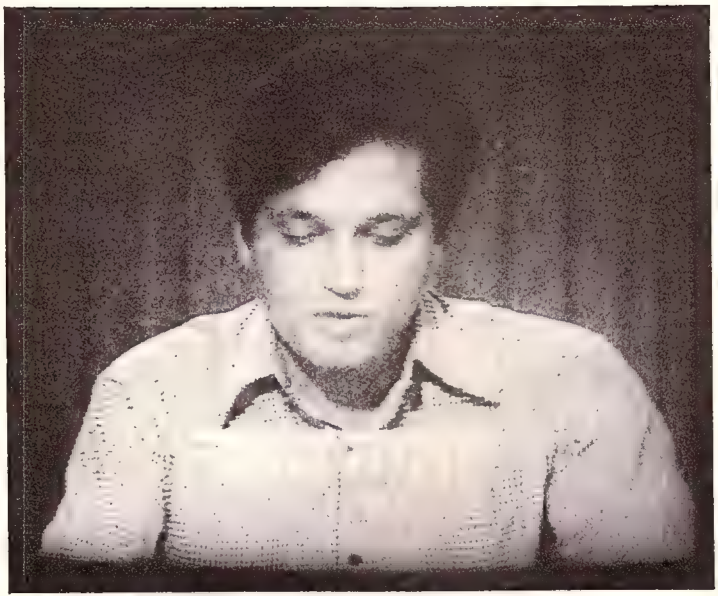


Fig.3B. **Received TV picture by coconut tree branch**

TREE TV

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the relative permitivity of water alone, which is the dominant content of the green vegetation foliage, is around 80 at microwave frequencies.

In the literature, low-loss dielectric-loaded aperture antennas and dielectric rod antennas are well-known for their directional beam-mode antenna radiation pattern. Low-loss dielectric rods have been used in practice, with Teflon, polystyrene ($\epsilon\approx 2.5$).

Thus after carrying out indepth studies of the dielectric data cited above, and the works of Zucker, King, Ulaby, Anderson, James et al, weconceived, intuitively, of the idea to use the green vegetation canopy as an antenna structure.

We concluded that a suitably located Papaya tree of height 3 to 5 metres (at 10 to 25km distance) has the properties to pick up Band 3 tv signals from the tv tower, which can be easily tapped by a suitable feeder line probe to the tv set.

However, no attempt was made to optimize the quality of tv picture received by the organic tree antenna structure, either by developing more efficient antenna probes or by adopting antenna arraying techniques. In-depth studies are called for to overcome the effects of hostile environments (wind, rain, snow) and to improve the s/n ratio of the received tv signals before any commercial venture can be thought of.

Continued from page 23

inclusion of $R_{52,53}$, $D_{1,2}$ forming a clamp at zero volts. Capacitors $C_{50,51}$ and C_{52} are bypass capacitors to reduce interference from switching spikes, r.f., etc. Switch-sense points at the junctions of R_x and C_x (S in Fig.1) are each taken to an input of a group of eight-to-one-bit multiplexers (IC_{1-8}) whose inverting outputs D_{7-0} provide a byte which can be read by the computer through the v.i.a. Control inputs of the multiplexers (A, B and C) are taken to a three-bit counter whose clock input is connected to CB_2 (programmed as an output) of the v.i.a. Capacitor C_{53} and R_{60} provide a reset to zero on switch on so that the counter always starts from a known position (see flow diagram).

Thus the whole keyboard is read in eight bytes. This gives a complete bit-map of the state of the keyboard, and some redundancy. After receiving eight clock pulses, the counter is back in its original state. The delay at the third operation in the flow diagram is introduced to allow for any residual key-bounce and for the fact that it is impossible to play all the notes of a chord simultaneously.

Figure 2 shows that only six of the eight inputs of IC_{1-7} are used, and only seven of IC_8. It would be possible to fit a 48-note keyboard using all the inputs of six multiplexers and it would not be necessary to provide an additional one for the extra note. However this would lead to reading only six bits per byte, causing either wasted memory if the inputs are to be stored or a complex software repacking procedure. Further, unless complicated wiring was used to connect keys to multiplexers (which would not lend itself well to p.c.b. layout), the bit-mapping involved would need extra software. The small additional cost of two extra multiplexers used offers two advantages.

— By taking six keys to each multiplexer (seven on the last one) an octave of 12 notes fits into two multiplexers. This makes it much easier to keep track of which bit represents which note.

— Bit zero (pin four) of all the multiplexers is grounded. Thus the first byte read should be FF (hexadecimal) since the outputs are inverting.

Keyboard software and control are outlined in a second article.

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DISC (PLATE)
E12 MICRO MINI
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±5%

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POLYCARB 5%
SIEMENS 7 5mm
MINI BLOC E12
250V

1nF to 6n8	7p
8n2 to 47nF	8p
56nF to 150nF	12p

100V

100nF to 150nF	13p
180nF to 270nF	16p
330nF to 390nF	25p
470nF to 560nF	32p
680nF	38p
1μF (10mm)	40p

POLYESTER
250V RADIAL
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10nF, 15nF	
22nF, 33nF	
47nF, 68nF	
100nF	7p
150nF, 200nF	10p
330nF, 470nF	13p
680nF	18p
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1 35V	14p
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33 35V	14p
47 35V	14p
68 35V	14p
10 35V	14p
2 2 35V	14p
3 3 35V	18p
4 7 16V	18p
4 7 35V	20p
6 8 25V	20p
6 8 35V	21p
10 16V	18p
10 35V	27p
15 10V	22p
15 16V	30p
15 25V	32p
22 6 3V	26p
22 16V	29p
33 10V	30p
47 3V	14p
47 6 3V	34p
47 16V	39p
100 3V	32p

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uFd	V	
47	63	8p
47	100	9p
47	350	30p
1	63	8p
1	100	9p
1	500	40p
2 2	25	8p
2 2	63	9p
2 2	100	11p
2 2	350	30p
3 3	25	10p
3 3	40	11p
3 3	63	12p
4 7	16	8p
4 7	25	9p
4 7	40	11p
4 7	63	12p
4 7	100	14p
10	25	8p
10	40	12p
10	63	14p
10	100	16p
10	350	55p
22	25	11p
22	40	14p
22	63	16p
22	100	21p
47	25	14p
47	40	17p
47	63	26p
47	100	28p
100	16	14p
100	25	16p
100	40	22p
100	63	25p
100	100	30p
220	10	16p
220	16	17p
220	25	22p
220	40	25p
220	63	30p
220	100	40p
470	16	22p
470	25	28p
470	40	33p
470	63	43p
470	100	60p
1000	16	30p
1000	25	38p
1000	40	46p
1000	63	65p
2000	16	40p
2200	25	63p
2200	40	70p
2200	63	1 34p
4700	16	75p
4700	25	89p

RADIALS (PCB
wires one end)
Matsushita only

uFd	V	
10	16	6p
22	10	6p
22	16	7p
47	10	7p
47	16	8p
100	10	9p
100	16	10p
220	10	11p
220	16	12p
470	10	17p
470	16	18p
1000	10	20p
1000	16	24p
2200	10	34p
2200	16	44p
3300	10	50p
3300	16	65p
4700	10	65p
4700	16	95p

74TTL

7400	75p
7401	24p
7402	29p
7403	29p
7404	35p
7405	35p
7406	1 69p
7407	1 69p
7408	35p
7409	35p
7410	35p
7411	35p
7412	35p
7413	35p
7414	55p
7416	1 49p
7417	1 49p
7420	35p
7421	35p
7422	35p
7423	35p
7425	35p
7426	35p
7427	35p
7428	35p
7430	35p
7432	95p
7433	35p
7437	35p
7438	95p
7440	29p
7441	69p
7442	58p
7444	65p
7445	75p
7446	75p
7447	65p
7448	75p
7450	29p
7451	29p
7453	29p
7454	29p
7460	29p
7470	49p
7472	49p
7473	35p
7474	49p
7475	49p
7476	49p
7480	59p
7481	1 29p
7482	99p
7483	69p
7484	99p
7485	99p
7486	39p
7489	1 99p
7490	45p
7491	59p
7492	49p
7493	39p
7494	99p
7495	49p
7496	59p
7497	1 75p
74100	1 39p
74104	59p
74105	59p
74107	45p
74109	45p
74110	69p
74116	1 25p
74118	1 25p
74119	1 25p
74120	1 25p
74121	45p
74122	49p
74123	79p
74125	49p
74126	49p
74128	65p
74132	59p
74136	49p
74141	79p
74142	1 99p
74143	1 99p
74144	1 99p
74145	89p
74147	99p
74148	99p
74150	1 39p
74151	59p
74153	59p
74154	1 99p
74155	55p
74156	55p
74157	55p
74159	1 29p
74160	79p
74161	59p
74162	59p
74163	59p
74164	75p
74165	85p
74166	99p
74170	1 49p
74172	2 49p
74173	75p
74174	89p
74175	69p
74176	69p
74177	69p
74178	99p
74180	69p
74181	1 59p
74182	69p
74184	1 49p
74185	1 49p
74190	69p
74191	75p
74192	85p
74193	69p
74194	55p
74195	59p
74196	55p
74197	89p
74198	1 50p
74221	1 50p

74LS TTL

74LS00	75p
74LS01	29p
74LS02	29p
74LS03	29p
74LS04	pls ask
74LS05	29p
74LS08	29p
74LS09	29p
74LS10	29p
74LS11	35p
74LS12	35p
74LS13	35p
74LS14	45p
74LS20	29p
74LS21	29p
74LS22	29p
74LS27	35p
74LS28	29p
74LS30	29p
74LS32	pls ask
74LS33	29p
74LS37	29p
74LS38	59p
74LS40	39p
74LS42	45p
74LS47	75p
74LS51	29p
74LS54	29p
74LS55	35p
74LS73	45p
74LS74	59p
74LS75	45p
74LS76	39p
74LS78	45p
74LS83	55p
74LS85	59p
74LS86	39p
74LS90	35p
74LS92	45p
74LS93	35p
74LS95	55p
74LS96	75p
74LS107	45p
74LS109	45p
74LS112	45p
74LS113	39p
74LS114	39p
74LS122	59p
74LS123	1 19p
74LS124	1 55p
74LS125	55p
74LS126	55p
74LS132	49p
74LS133	39p
74LS136	45p
74LS138	89p
74LS139	59p
74LS145	95p
74LS147	1 35p
74LS148	1 25p
74LS151	59p
74LS153	59p
74LS154	2 35p
74LS157	69p
74LS158	69p
74LS160	75p
74LS161	75p
74LS162	75p
74LS163	85p
74LS164	5p
74LS165	99p
74LS168	1 39p
74LS169	1 29p
74LS170	99p
74LS173	99p
74LS174	65p
74LS175	85p
74LS181	1 05p
74LS183	1 45p
74LS190	65p
74LS191	65p
74LS192	65p
74LS193	65p
74LS194	65p
74LS195	65p
74LS196	65p
74LS197	65p
74LS221	1 15p
74LS240	1 99p
74LS241	1 99p
74LS242	1 99p
74LS243	1 99p
74LS244	2 95p
74LS245	3 25p
74LS247	1 99p
74LS248	1 99p
74LS249	1 99p
74LS251	75p
74LS253	75p
74LS257	75p
74LS258	75p
74LS259	1 19p
74LS261	99p
74LS266	55p
74LS273	pls ask
74LS275	1 75p
74LS279	65p
74LS280	1 75p
74LS283	75p
74LS290	75p
74LS293	65p
74LS295	75p
74LS298	75p
74LS299	1 75p
74LS323	2 25p
74LS324	1 75p
74LS325	1 75p
74LS326	2 99p
74LS327	2 99p
74LS347	75p
74LS348	1 75p
74LS352	85p
74LS353	85p
74LS362	1 99p
74LS365	49p
74LS366	49p
74LS367	49p
74LS368	49p
74LS373	2 80p
74LS374	2 80p
74LS378	99p
74LS386	75p
74LS390	75p
74LS393	99p
74LS395	99p
74LS396	2 95p
74LS398	1 29p
74LS399	1 29p
74LS445	99p
74LS490	1 15p
74LS540	1 19p
74LS541	1 45p
74LS640	2 50p
74LS641	2 50p

CMOS

4000	18p
4001	18p
4002	18p
4006	69p
4007	25p
4008	79p
4009	55p
4010	29p
4011	22p
4012	29p
4013	49p
4015	65p
4016	45p
4017	69p
4018	69p
4019	55p
4020	89p
4021	69p
4022	69p
4023	39p
4024	69p
4026	89p
4027	45p
4028	53p
4029	69p
4030	39p
4031	1.35p
4032	89p
4034	1.99p
4035	69p
4036	2 69p
4038	1 19p
4040	59p
4041	59p
4042	59p
4044	59p
4045	1 19p
4046	75p
4047	75p
4048	54p
4049	45p
4050	49p
4051	75p
4052	69p
4053	59p
4054	79p
4056	99p
4059	4 49p
4060	69p
4063	89p
4066	44p
4067	2 39p
4068	27p
4069	27p
4070	27p
4071	27p
4072	27p
4073	27p
4075	27p
4076	65p
4077	27p
4078	27p
4081	27p
4085	59p
4086	69p
4089	1 25p
4093	65p
4094	99p
4095	89p
4096	89p
4098	99p
4099	1 09p
40103	2 59p
4502	59p
4503	59p
4505	3 75p
4507	45p
4508	1 49p
4510	69p
4511	69p
4512	69p
4514	1 25p
4515	1 25p
4516	89p
4518	69p
4519	75p
4520	75p
4521	1 05p
4522	89p
4526	89p
4527	89p
4528	75p
4529	89p
4532	89p
4534	3 95p
4536	2 29p
4538	89p
4543	99p
4553	2 19p
4555	58p
4556	58p
4560	1 79p
4566	1 99p
4569	1 99p
4584	49p
4585	64p

LOGIC

CPUs

1802	6 49p
6502	3 99p
6502A	6 49p
6800	2 75p
6802	2 99p
6809	9 95p
8035	5 45p
8039	5 45p
8080A	3 55p
8085	9 45p
Z80A CPU	3 59p
Z80B CPU	9 45p

MEMORIES

2114	pls ask
2532	4 25p
2564	6 95p
2708	3 95p
2716 (5v)	3 45p
2764	8 99
4116	pls ask
4118	4 39p
4164	4 99p
6116	pls ask
6810	1 95p

MISC LOGIC IC's

ADC0804	pls ask
ADC0816	pls ask
ADC0817	pls ask
INS1771	pls ask
RO2513LC	7 50p
RO2513UC	7 50p
SAA5000	4 05p
SAA5010	7 81p
SAA5012	7 81p
SAA5020	5 95p
SAA5030	6 99p
SAA5040	15 95p
SAA5041	15.95p
SAA5050	8 95p
SAA5070	18.95p
8T26	1.19p
8T28	1 19p
8T95	99p
8T97	99p
81LS95	2 27p
81LS96	2 27p
81LS97	2.27p
81LS98	2.27p
6522	3.69p
6522A	5.55p
6532	6 45p
6821	1.99p
6840	3.75p
6845	6 49p
6847	6.49p
8154	pls ask
8155	pls ask
8212	pls ask
8216	pls ask
8224	pls ask
8226	pls ask
Z80ACTC	3 49p
Z80ADART	8.39p
Z80APIO	3 45p
ZN425E8	3 49p
ZN426E8	3 10p
ZN427E8	5 99p
ZN428E8	4.55p

V REGS

– Positive –
100mA

78L05A	29p
78L12A	29p
78L15A	29p
78L24A	29p

1 Amp TO202

7805T	45p
7812T	45p
7815T	45p
7824T	45p

– Negative –
100mA TO92

79L05	49p
79L12	49p
79L15	49p

1 Amp T0220

7905T	57p
7912T	57p
7915T	57p
7924T	57p

TRANSISTORS

2N2219	33p
2N2219A	36p
2N2220	33p
2N2221A	33p
2N2222	29p
2N2222A	33p
2N2223	5.85p
2N2223A	6 25p
2N2368	33p
2N2369	34p
2N2369A	35p
2N2904A	35p
2N2905	35p
2N2905A	38p
2N2906	35p
2N2907	35p
2N2907A	38p
2N2926	13p
2N3053	35p
2N3054	65p
2N3055	65p
2N3055H	1 89p
2N3439	1 15p
2N3440	99p
2N3441	1 49p
2N3442	1 59p
2N3638	62p
2N3702	16p
2N3703	16p
2N3704	16p
2N3705	16p
2N3706	16p
2N3707	16p
2N3708	16p
2N3709	31p
2N3710	34p
2N3711	37p
2N3773	2 09p
2N3819	55p
2N3902	6 88p
2N3903	19p
2N3904	19p
2N3905	19p
2N3906	19p
2N4030	88p
2N4031	82p
2N4032	87p
2N4036	72p
2N4037	66p
2N4400	19p
2N4401	33p
2N4402	37p
2N4902	2 25p
2N4903	2 38p
2N4904	2 46p
2N4905	2 99p
2N4906	3 09p
2N4907	3 42p
2N4908	3 58p
2N4909	3 15p
2N5089	43p
2N5190	75p
2N5191	79p
2N5193	99p
2N5194	83p
2N5245	46p
2N5246	59p
2N5247	63p
2N5248	65p
2N5249	67p
2N5266	3 25p
2N5401	57p
2N5415	1 36p
2N5416	1 73p
2N5447	29p
2N5448	31p
2N5449	27p
2N5450	63p
2N5451	66p
2N5457	39p
2N5458	39p
2N5459	31p
2N5460	83p
2N5551	41p
2N6121	91p
2N6122	93p
2N6123	99p
2N6124	1 01p
2N6125	1 03p
2N6126	1 09p
2N6129	99p
2N6130	1 05p
2N6131	1 23p
2N6132	1 09p
2N6133	1 15p
2N6134	1 33p
2N6253	1 63p
2N6254	1 77p
2SC1306	99p
3N201	1.99p
40361	75p
40362	75p
40363	3 99p
40406	1 75p
40408	1 75p
40410	1 99p
40411	3 99p
40673	1 49p
40822	1 99p
AC125	99p
AC126	35p
AC127	35p
AC128	39p
AC141K	39p
AC142K	39p
AC151	77p
AC152	77p
AC153	77p
AC153K	87p
AC176	39p
AC176K	49p
AC187	39p
AC188	39p
AC187K	49p
AC188K	49p
BC107	16p
BC107A	17p
BC107B	19p
BC108	16p
BC108A	17p
BC108B	18p
BC108C	20p
BC109	17p
BC109B	18p
BC109C	21p
BC140	38p
BC141	43p
BC147	15p
BC147A	16p
BC147B	17p
BC147C	27p
BC148	15p
BC148A	17p
BC148B	19p
BC148C	25p
BC149	16p
BC149B	19p
BC149C	26p
BC157	39p
BC157A	41p
BC157B	44p
BC158A	37p
BC158B	39p
BC159	44p
BC159A	45p
BC159B	46p
BC159C	48p
BC160	55p
BC161	59p
BC167	19p
BC169	19p
BC169B	22p
BC169C	23p
BC177	29p
BC177A	33p
BC177B	36p
BC178	29p
BC178A	33p
BC178B	36p
BC179	31p
BC179B	39p
BC179C	41p
BC182	15p
BC182A	17p
BC182B	19p
BC182L	15p
BC182LA	17p
BC182LB	19p
BC183	14p
BC183A	16p
BC183B	19p
BC183C	25p
BC183L	15p
BC183LA	16p
BC183LB	18p
BC183LC	23p
BC184	16p
BC184B	19p
BC184C	24p
BC186	29p
BC187	29p
BC212	16p
BC212A	18p
BC212B	21p
BC213	17p
BC213A	18p
BC213B	19p
BC213C	24p
BC213L	15p
BC213LA	16p
BC213LB	19p
BC213LC	23p
BC214	18p
BC214B	22p
BC214C	27p
BC214L	19p
BC214LB	21p
BC214LC	26p
BC300	59p
BC301	59p
BC302	59p
BC303	59p
BC327	16p
BC327A	19p
BC327B	23p
BC327C	25p
BC440	35p
BC441	37p
BC460	38p
BC461	42p
BC547	19p
BC550C	29p
BC560C	29p
BCY70	31p
BCY71	33p
BCY72	25p
BD124	2 99p
BD131	63p
BD132	63p
BD135	38p
BD136	38p
BD137	39p
BD138	39p
BD139	42p
BD140	42p
BD239A	65p
BD239C	69p
BD240A	68p
BD240C	79p
BD241A	72p
BD241C	79p
BD242A	75p
BD242C	79p
BD243A	85p
BD243C	89p
BD244A	88p
BD244C	1 15p
BD245A	1 19p
BD245C	1 49p
BD246A	1 39p
BD246C	1 67p
BD249A	2 30p
BD249C	2 57p
BD250A	2 48p
BD250C	2 75p
BD529	1 75p
BD530	1 95p
BD535	89p
BD536	89p
BD537	97p
BD538	97p
BD539	1 08p
BD539C	1 33p
BD540	1 04p
BD540C	1 39p
BDX66B	6 35p
BDX67B	6 35p
BDY54	2 28p
BDY55	2 39p
BDY56	1 99p
BDY57	5.91p
BDY58	6.33p
BF194	18p
BF195	18p
BF196	18p
BF197	18p
BF198	18p
BF199	18p
BF200	79p
BF244A	61p
BF244B	55p
BF245A	63p
BF245B	66p
BF246	77p
BF246A	79p
BF246B	79p
BF247A	79p
BF247B	79p
BF254	66p
BF255	68p
BF256A	59p
BF256B	59p
BF256C	69p
BF257	39p
BF258	41p
BF259	45p
BF457	48p
BF458	59p
BF459	65p
BFR39	32p
BFR40	32p
BFR41	32p
BFR79	32p
BFR80	32p
BFR81	32p
BFR90	2 25p
BFS61	99p
BFS98	99p
BFX29	44p
BFX30	46p
BFY53	53p
BSX19	29p
BSX20	33p
BSX21	49p
BU104	2 32p
BU105	1 89p
BU108	2 49p
BU109	2 49p
BU126	1 55p
BU204	2 49p
BU205	1 99p
BU206	2 16p
BU208	1 93p
BU226	4 45p
BU326S	2 63p
BU406	1 45p
BU407	1 58p
BU408	1 49p
BU409	1 65p
BU500	3 56p
BUY18S	4 33p
E430	6 32p
J300	88p
J310	88p
MJ802	4 25p
MJ900	3 21p
MJ901	3 39p
MJ1000	2 76p
MJ1001	3 26p
MJ1800	3 79p
MJ2500	2 39p
MJ2501	2 63p
MJ2955	99p
MJ3000	2 39p
MJ3001	2 63p
MJ4502	4 25p
MJE340	75p
MJE350	1 49p
MJE2955	1 99p
MJE2955T	95p
MJE3055	1 59p
MJE3055T	69p
MPSA05	29p
MPSA06	33p
MPSA10	59p
MPSA12	49p
MPSA13	49p
MPSA14	49p
MPSA20	49p
MPSA42	49p
MPSA43	48p
MPSA55	29p
MPSA56	33p
MPSA65	62p
MPSA66	65p
MPSA70	49p
MPSA92	49p
MPSA93	48p
MPSL01	69p
MPSL51	75p
MPS405	89p
MPSU06	99p
MPSU07	1 75p
MPSU51	1 29p
MPSU56	1 22p
MPSU57	1 95p
TIP29A	35p
TIP29C	42p
TIP30A	37p
TIP30C	44p
TIP31A	39p
TIP31C	47p
TIP32A	46p
TIP32C	49p
TIP33A	69p
TIP33C	83p
TIP34A	1 19p
TIP34C	1 26p
TIP35A	1 26p
TIP35C	1 39p
TIP36A	1.42p
TIP36C	1 49p
TIP41A	52p
TIP41C	58p
TIP42A	62p
TIP42C	65p
TIP49	1 29p
TIP50	1 52p
TIP53	1 58p
TIP54	1 65p
TIP110	79p
TIP112	85p
TIP115	89p
TIP117	1 05p
TIP120	79p
TIP122	85p
TIP127	99p
TIP130	1 06p
TIP132	1 09p
TIP135	1 16p
TIP137	1 19p
TIP140	1.21p
TIP142	1 22p
TIP145	1 21p
TIP147	1 22p
TIP162	4 99p
TIP2955	81p
TIP3055	79p
TIS43	61p
VN10KM	69p
VN46AF	1 15p
VN66AF	1 09p
ZTX107	12p
ZTX108	13p
ZTX109	14p
ZTX300	12p
ZTX301	16p
ZTX302	17p
ZTX303	25p
ZTX304	18p
ZTX310	39p
ZTX311	36p
ZTX312	39p
ZTX313	41p
ZTX314	27p
ZTX320	37p
ZTX330	39p
ZTX341	31p
ZTX450	41p
ZTX500	15p
ZTX501	15p
ZTX502	15p
ZTX503	18p
ZTX504	19p
ZTX510	28p
ZTX531	29p
ZTX650	47p
ZTX651	48p
ZTX652	49p
ZTX653	50p
ZTX750	47p
ZTX751	48p
ZTX752	49p
ZTX753	50p

DIODES

IN34A	52p
IN821	70p
IN823	92p
IN914	4p
IN916	6p
IN4001	4p
IN4002	4½p
IN4003	5p
IN4004	5½p
IN4005	6p
IN4006	6½p
IN4007	7p
IN4009	20p
IN4148	3p
IN4150	18p
IN4448	22p
IN5400	12p
IN5401	13p
IN5402	14p
IN5404	16p
IN5406	18p
IN5407	19p
IN5408	20p
BA102	49p
BA115	29p
BA133	51p
BA138	36p
BA142	25p
BA155	18p
BA156	41p
BA157	28p
BA158	34p
BA159	38p
BA182	49p
BA201	23p
BA202	29p
BA316	27p
BA317	28p
BA318	31p
BAX13	21p
BB105	65p
BB109G	69p
BY126	12p
BY127	14p

SCR's TRIACS DIACS

THYRISTORS
4 8 & 12 Amps
Texas T0220
Suffix A = 100V
B = 200V
C = 300V
D = 400V
M = 600V

4A	
TIC106A	49p
TIC106B	51p
TIC106C	53p
TIC106D	55p
TIC106M	72p
8A	
TIC116A	69p
TIC116B	72p
TIC116C	75p
TIC116D	78p
TIC116M	84p
12A	
TIC126A	74p
TIC126B	75p
TIC126C	76p
TIC126D	79p
TIC126M	99p

TRIACS
Texas 400V
TO220 Case

TIC206D(4A)	69p
TIC225D(6A)	79p
TIC226D(8A)	92p
TIC236D(12A)	1.25p
TIC246D(16A)	1 35p
TIC253D(20A)	1 99p
TIC263D(25A)	2 25p

DIACS

BR100	29p
ST2	29p

ZENER'S

many inc
specials see our
CAT
400 to 500mW
E24 Series

2.4 to 47V	7p

1 3 Watt
E24 Series

3.3 to 82V	14p

BRIDGE

(PIV shown in
brackets)

1½ amp type

W01(100)	28p
WO2(200)	34p
WO4(200)	38p
WO8(800)	50p

2 amp type
Square with hole

S01(100)	46p
S02(200)	50p
S04(400)	55p
S08(800)	66p

6 amp type
Square with hole

PW01(100)	95p
PW02(200)	99p
PW04(400)	1.30p
PW06(600)	1 39p

25 amp type
Metal clad with
hole

K01(100)	2 62p
K02(200)	2 75p
K04(400)	3.25p
K06(600)	4 10p
BYW64	
35A 400V	4 50p

OPTO

many inc
specials see our
CAT
LED LAMPS
R = Red
G = Green
Y = Yellow

Large diffused 1+

R5D	9p
G5D	16p
Y5D	15p

Small diffused

R3D	8p
G3D	12p
Y3D	12p

Micro 0.1"

RIM	27p
GIM	29p
YIM	29p

Large clear

R5C	12p
G5C	17p
Y5C	17p

Super bright
high efficiency
Large (100 times
brighter)

R5U	38p
G5U	42p
Y5U	42p

Rectangular
Stackable LEDs

R5R	18p
G5R	19p
Y5R	21p

LIN ICs

AY15050	99p
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HA1366W	2.40p
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ICL7106	7.50p
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ICM7555	1.10p
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LC7130	3.40p
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LF347	1 50p
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LM335Z	1.60p
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LM349N	1.09p
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LM379S	5 50p
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LM380NB	1.50p
LM381AN	2.26p
LM381N	1.40p
LM382N	1.22p
LM383T	3.40p
LM384N	1.40p
LM386N	1 20p
LM388N	2 43p
LM391N60	2 25p
LM391N80	1 65p
LM723CH	99p
LM723CN	49p
LM725CH	3 40p
LM725CN	3 19p
LM741CH	96p
LM741CN	19p
LM741CN14	80p
LM747CN	69p
LM748CH	1 00p
LM748CN	42p
LM1871	3.25p
LM1872	4 39p
LM1877	5 95p
LM1886	7 44p
LM1889	3 77p
LM2907N	2 75p
LM2907N8	2 60p
LM2917N	2.40p
LM2917N8	2.40p
LM3900	62p
LM3911	1 45p
LM3914	3.25p
LM3915	3 25p
LM13600	1.15p
MF10	3.75p
NE531N	1 36p
NE543N	2 50p
NE544N	1 95p
NE555	22p
NE556	65p
NE558	1 89p
NE560	3 25p
NE565	1.18p
NE566	1.49p
NE567	1.37p
NE570	4.07p
NE571	3 99p
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RC4194	3.95p
RC4195	2.95p
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SN76477	7 95p
SN76003	3.45p
SN76013	3 45p
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TA7204	1 99p
TA7205	1 20p
TA7222	1 75p
TA7227	5.82p
TBA500	2.97p
TBA500Q	3.11p
TBA510	2 95p
TBA510Q	3 05p
TBA520	2.57p
TBA520Q	2 75p
TBA530	2 55p
TBA530Q	2.76p
TBA540	2 72p
TBA540Q	2 74p
TBA550	3 25p
TBA550Q	3 27p
TBA560C	2.87p
TBA570	2 37p
TBA570Q	2 48p
TDA1002	3 39p
TDA1003	4.35p
TDA1004	P.O.A
TDA1004A	5.45p
TDA1005	4 35p
TDA1010A	2.25p
TDA1022	4.95p
TDA2002	3.25p
TDA2003	3.25p
TDA2020	3 15p
TDA2030	2.85p
TDA2611A	2.50p
TDA7000	3 45p
TL061	51p
TL062	77p
TL064	1 35p
TL071	47p
TL072	62p
TL074	1.35p
TL081	47p
TL082	55p
TL084	1 20p
UAA170	2.49p
UAA180	2.49p
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Enough to make
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203 × 114	2 40p
233 × 220	5.20p

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Developer for
above (do not
use Sodium
Hydroxide)

500ml	2.95p

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Above 15.59p

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DPDT C OFF	90p
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CIRCLE 69 FOR FURTHER DETAILS.

SC84 Micro-computer

The third module of John Adams' disc-based professional microcomputer for engineers and enthusiasts provides a c.r.t. display of more than 3000 text characters, 36000 picture elements, or a mixture of text and graphics.

by J. H. Adams

A visual-display unit, v.d.u., passes information from a computer to its operator. It consists of a display device — a monitor or a tv — and digital circuits to control an area of memory holding a representation of the image to be displayed. Data written into this memory from the computer is read out for processing and combination with control signals to produce the necessary monitor input signals. This being a vital part of a computer, large-scale integrated circuits of varying complexity have been produced to simplify the design of v.d.u digital circuits. There are two fundamental types of v.d.u. circuit, memory-mapped and i/o-mapped.

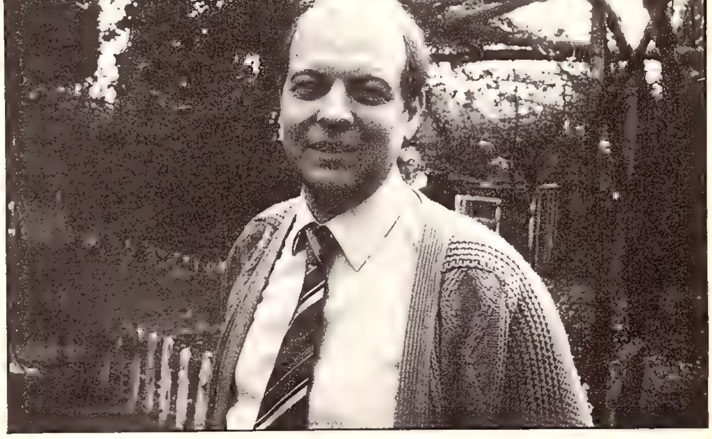
In a memory-mapped system, memory storing characters to be displayed on the screen is part of the system's addressable memory. The advantage of memory mapping is that the processor can make rapid transfers to and from the v.d.u. — as fast as its own memory cycle — which for a Z80B means 300 000 characters per second. Also, as the memory is under processor control, it is relatively easy to implement unusual screen features such as scrolling the display left or down. The main disadvantage is that the v.d.u. memory takes up memory available for programs unless paging is used and, as the screen resolution and hence the amount of memory required for a display increases, less and less of the addressable memory remains for the program.

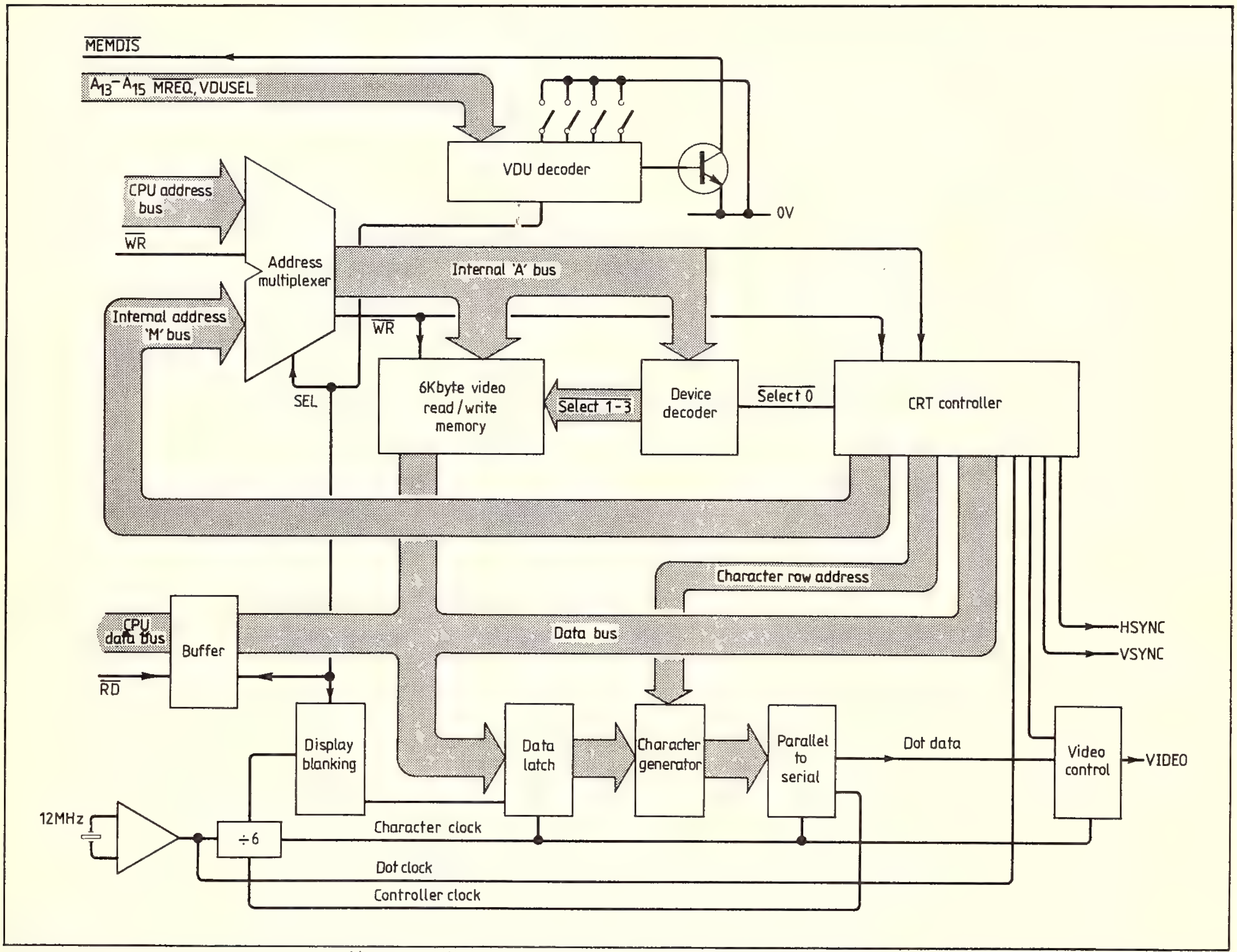
Paging is a technique where a block of memory can be temporarily switched in place of another. Use of paging means that v.d.u. memory doesn't appear to take up any space in the main memory map, with the proviso that software that sends information to the v.d.u. mustn't be in the memory segment switched out when the v.d.u. is switched in, and the penalty that v.d.u. access is slowed down by extra switching software. Other problems with memory-mapped v.d.us are the extra circuits required to switch address lines to the v.d.u. memory, the arbitration needed and the screen disturbance which can occur when the c.p.u. accesses the memory. The problem of arbitration is most relevant when dynamic memory, with its need for orderly memory access, is used. As dynamic memory is cheaper and as higher resolution requires more and more memory, this can lead to extra complexity or expense. With static memory it is simply a matter of giving the c.p.u., which will after all control the arbitration process, priority in addressing and accessing v.d.u. memory. The disturbance occurs when the c.p.u. gains control during an active-display period. The v.d.u. control circuits take bytes from memory in an orderly manner and pass them on for processing into video information. When a c.p.u. cycle occurs this is interrupted, the location addressed and the data on the bus lines being different from that planned by the v.d.u. controller. The result is speckling on the screen which, particularly during scrolling can almost obliterate the wanted information. Common solutions to this are to force the video output to the 'black' state during c.p.u. accesses or to only allow access to the v.d.u. during flyback periods — i.e. when the video is naturally suppressed. Unless done carefully, selective blacking can noticeably reduce display intensity; the second solution reduces the rate at which characters can be passed to the screen.

Terminal-type or i/o-mapped v.d.us appear to the c.p.u. as input/output channels, so their advantage is in not occupying any system memory. Their disadvantage is in circuit complexity. Circuits must be provided for receiving and interpreting commands as well as data. For example the i/o-mapped v.d.u. must recognize a request for the character at a particular screen location (including transfer of the screen coordinates — information implicit in a memory-mapped access), or the need to clear the rest of the current display line and return the cursor or next-screen-location pointer to the left-hand margin on receiving the carriage return control character. It is common practice to pass data to

John Adams, with a B.Sc. and M.Sc. from University College of North Wales, is head of the microprocessor division of Graseby Dynamics Ltd. Prior to working in industry he held various educational posts during which he initiated the teaching package 'Starting microelectronics'. This, his second series of articles for *Electronics and Wireless World*, combines his interests in education and engineering.

In his spare time, John is a keen classical organist.




MEMDIS
A_{13}–A_{15} MREQ, VDUSEL
VDU decoder
0V
CPU address bus
WR
Address multiplexer
Internal 'A' bus
Internal address 'M' bus
WR
6Kbyte video read/write memory
Select 1-3
Device decoder
Select 0
CRT controller
SEL
Character row address
CPU data bus
Buffer
Data bus
HSYNC
VSYNC
RD
Display blanking
Data latch
Character generator
Parallel to serial
Dot data
Video control
VIDEO
12MHz
÷6
Character clock
Dot clock
Controller clock

Designed chiefly for fast clear high-density text display, the monochrome v.d.u. section of SC84 is memory mapped and uses the pipelining technique. Output is separete video and sync. signals in either polarity.

Fig.1. SC84's monochrome v.d.u. circuit, right, uses an enhanced version of the 6845 c.r.t. controller with light-pen register and interlaced video facility to give 32 lines of 96 characters and up to 192 by 192 pixels for graphics. Using an eprom character generator is cheaper than using a proprietary rom and allows reprogramming. Switching is included to relocate the v.d.u. section for experimentation.

an i/o mapped v.d.u. in serial form, which restricts the character rate to about 1000/s. Processor i/o operations are not so various or fast as memory ones, making something of a bottleneck of the i/o channel, however the possible division of processing between the main c.p.u. and the v.d.u. circuits can lead to a reasonably fast system. Also, as v.d.u. memory only has one controller it can be dynamic without any problems arising.

It should now be apparent that there are pros and con's to both methods. There are further reasons affecting the choice. Wordstar, a popular word-processing program, is an example of software which can work well with either system but which shows off its best features when modified for use with a memory-mapped v.d.u. My solution is to use both systems — a memory-mapped display for monochrome characters and medium resolution graphics and an i/o system for high-resolution colour graphics*. This prompts use of two monitors — a monochrome one for dense character display, where typically close-up use renders a colour monitor tiresome to read unless perfectly adjusted, and a full colour output with the option of character formation.

Controllers

The Hitatchi HD6845S used in this design (until recently numbered HD46505S) is a developed form of the popular 6845 v.d.u. controller. Its advantage to the computer designer is flexibility, virtually all design parameters (e.g. characters per line, lines per screen, sync. pulse length etc.) being stored in registers loaded by the c.p.u. rather than being fixed. In the Hitatchi version capabilities of these registers are extended; these capabilities are used in this design so it is important to use the specified device. While it can be used for graphic displays, its primary intent is as a character-display controller and to this end it has control lines which can be fed to a character generator (a rom which produces dot patterns corresponding to characters placed in the v.d.u. memory), and skewed video control lines, i.e. signals which can be delayed internally by one or two characters periods to allow a technique called 'pipelining' to be used. 'Pipelining' is a technique used in complex v.d.us whereby v.d.u. memory and character generator outputs are latched in synchronism with the character display rate. Whatever the speed of memory accesses, providing they are each shorter than one character display period (500ns in this system), data passes, or is 'piped' synchronously through the v.d.u. Being able to skew the display and cursor enabling systems means that it is easier to ensure that control and data information appear together at the end of the 'pipeline' (see the timing diagram). The controller provides a register for positioning a cursor which can be made to flash, a register for use with a light pen and a facility for interlaced video. Together with multi-

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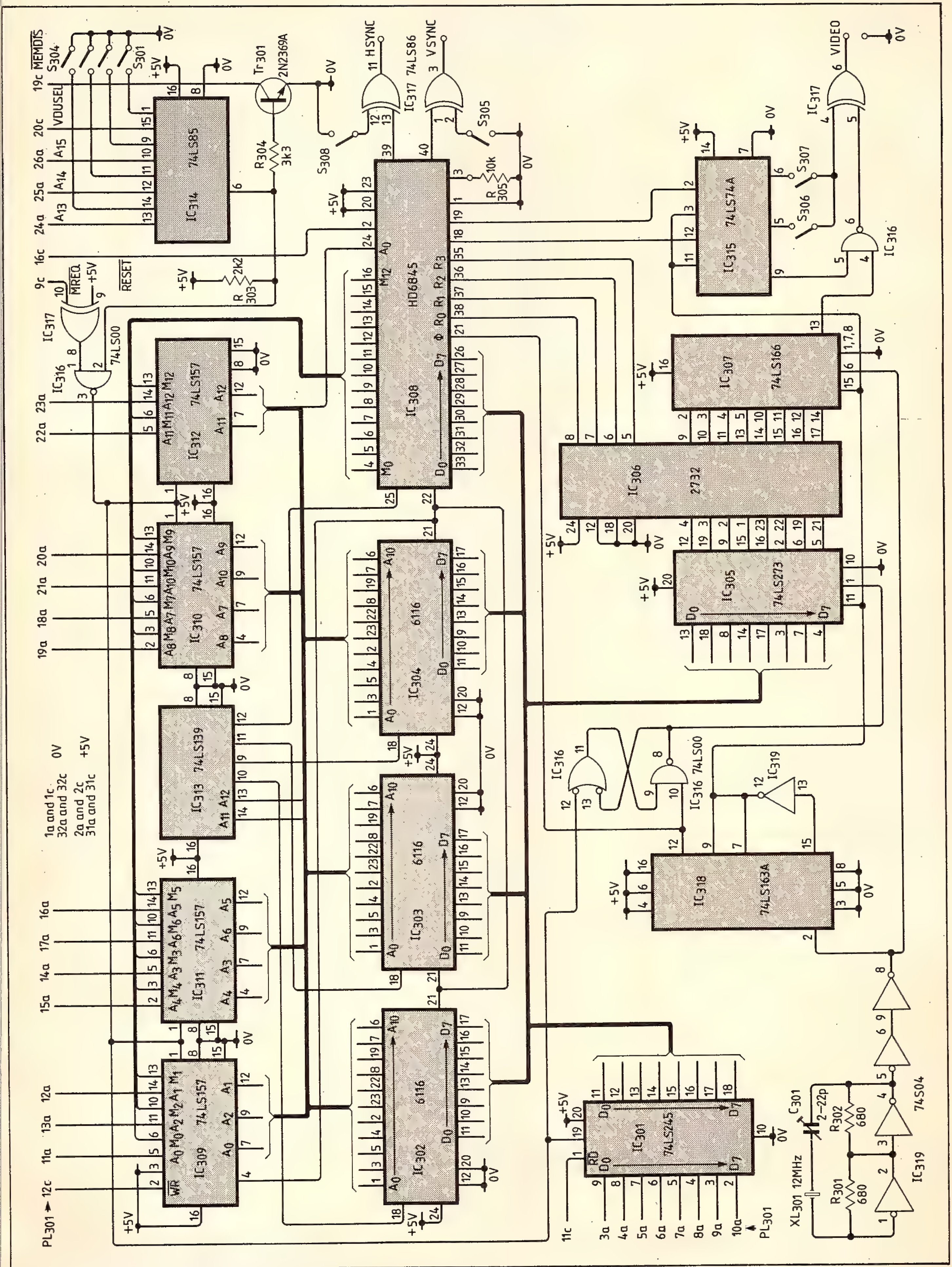
* John Adams is currently working on the high-resolution colour system which we plan to describe in a future article - Ed.


PL301
12c
11a
13a
12a
15a
14a
17a
16a
19a
18a
21a
20a
22a
23a
9c
16c
24a
25a
26a
20c
19c
MEMDIS
VDUSEL
A13
A14
A15
S304
S301
+5V
0V
IC314
74LS85
Tr301
2N2369A
R304
3k3
R303
2k2
RESET
MREQ
IC317
IC316
74LS00
IC309
74LS157
IC310
74LS157
IC311
74LS157
IC312
74LS157
IC313
74LS139
A11 A12
1a and 1c
32a and 32c
2a and 2c
31a and 31c
IC302
6116
IC303
6116
IC304
6116
IC308
HD6845
S308
HSYNC
VSYNC
IC317 74LS86
S305
R305
10k
IC306
2732
IC307
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IC305
74LS273
IC315
74LS74A
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S306
VIDEO
IC318
74LS163A
IC319
74S04
IC301
74LS245
RD
XL301 12MHz
C301
2–22p
R301
680
R302
680
11c
3a
4a
5a
6a
7a
8a
9a
10a

plexers selecting memory, c.p.u. or controller lines, some high-speed logic too fast to build into the nmos controller, and memory it forms the character v.d.u.

The NEC µPD7220 is one of a new generation of graphics controller designed for i/o mapping but offering a degree of internal complexity which overcomes many of the objections to i/o mapping. Designed to control up to 256K words (1 word = 16 bits) of dynamic memory, it appears to the c.p.u. as two i/o ports and optionally a d.m.a. channel. Using i/o ports for commands and d.m.a. for data, rapid access to v.d.u. memory is possible. For graphic functions such as shape drawing or filling areas, the 7220 can be given parameters and then commanded to draw - which it can do at over one million picture elements (pixels) per second without further c.p.u. involvement. Other internal features are full refresh, zooming (expansion of one part of the display to fill the entire screen) and the option of flash-free memory update (i.e. memory access during flyback period only). Details of the graphics display and of programming techniques for both controllers will appear in a later article.

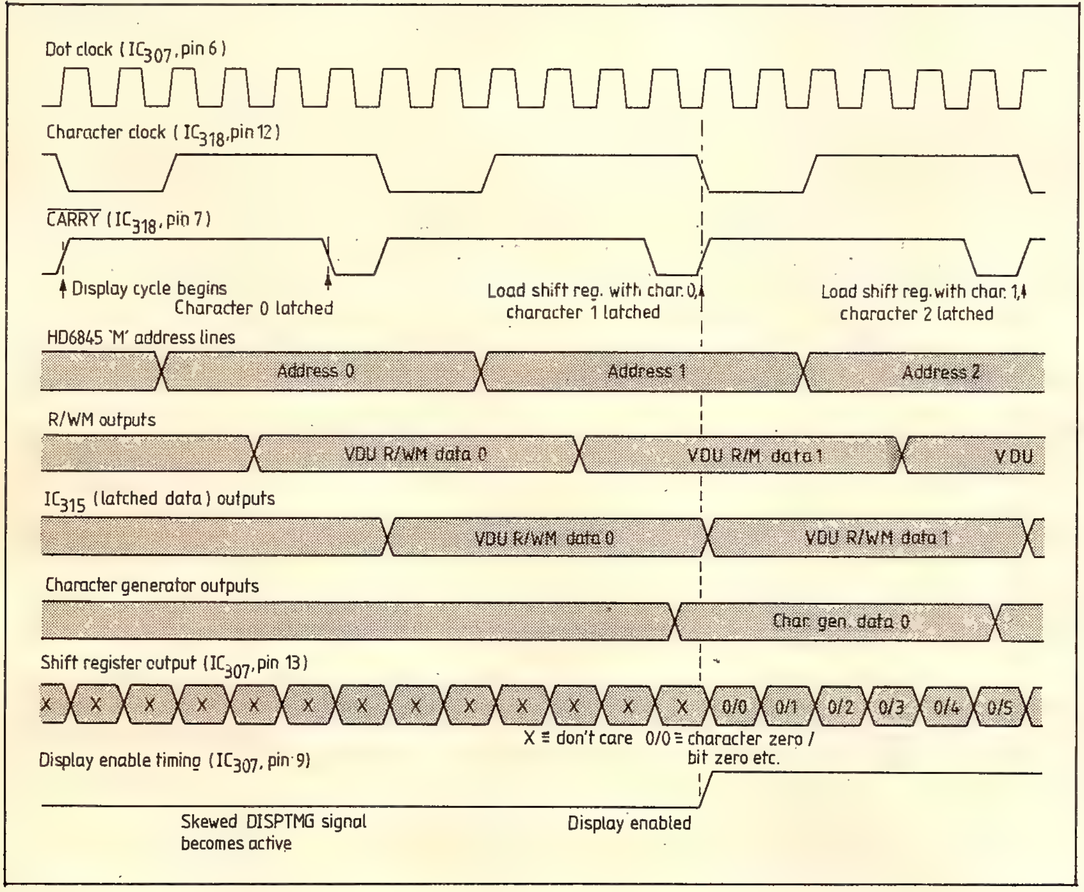
Figure 1 shows the character v.d.u. circuit. As most c.r.t. controllers, the HD6845S is designed for use in raster-scanning systems, i.e. with a normal, television-like display where the cathode-ray tube spot writes lines across the screen from left to right while being progressively swept down the screen. This means that one character is not completely drawn on the screen before the next. As the spot moves across the screen, successive character codes are taken from v.d.u. memory and just one row of dots from each of the corresponding character pattern is taken from the character generator rom and displayed on the v.d.u. At the start of the next c.r.t. line the v.d.u. memory address reverts to the same value as that of the start of the line but a different row of dots is selected from the character generator. Only when the last dot row has been drawn is the memory address allowed to step to the next area of v.d.u. memory. The number of characters on line and the number of dot rows, or rasters, is set by loading values into the controller when the Z80 is initializing the system. These factors control v.d.u. memory address lines M_{0-12} and row-address lines R_{0-3}.

In this system displayed characters are six dots wide by nine dots high; this pattern includes the space (one dot column) between adjacent characters and the space (two dot rows) between adjacent display lines. The two-dot horizontal space is used by lower-case letters with descenders (g, p, q, etc.). The fastest event in the v.d.u. is sending of a pixel to the display and a signal at this frequency is generated by the 12MHz dot-clock oscillator, (IC_{319}). This signal is divided by six in a programmable divider to give a signal running at the character-display frequency, the character clock. This division, and all operations at the dot frequency, is done outside the controller as the frequencies involved are too high for most technology used in the HD6845S. Note that the character generator is an eprom. Not only are they cheaper than proprietary character generator roms but they allow you to change the character set to suit your own requirements. Even the number of dots making up a character can be altered, up to an eight-by-16 matrix, but this is rather advanced work.

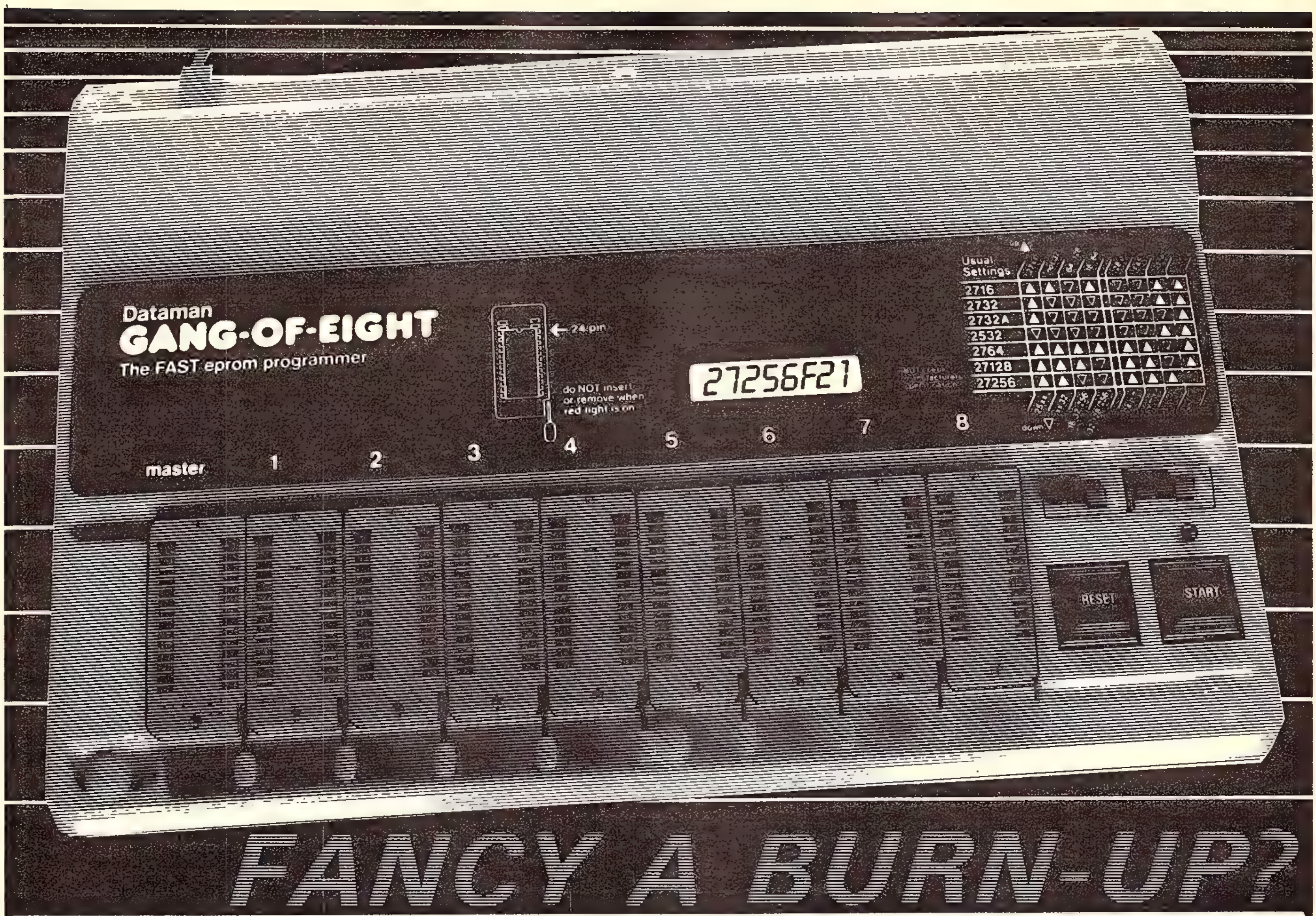
Circuit IC_{318} is a four-bit programmable counter. It provides a 'carry' pulse at pin 15 as it passes through its maximum count value - binary 1111 - and this signal loads the binary value on pins six to three instead of allowing the counter to count on to zero on the next dot clock pulse. This value is binary 1010 - denary 10 - so the counter counts through six states, binary 1010 to 1111, before repeating. Divider output C provides the character clock signal fed to the controller. An inverted carry pulse is used to provide a clocking and/or loading signal throughout the logic outside the controller.

Synchronization is extremely important. As one can see from the timing diagram there are many delays between the rising edge of the character clock initiating the addressing sequence and the production of a dot pattern at the output of the character generator, and between this point and the coming of those dots and control signals for display blanking, etc., from the controller. The timing diagram is to scale and incorporates the worst-case delays specified for the i.cs. Two signals used to synchronize the system are rising edges of dot clock and carry signal. To cope with delays between the controller generating an M-line address and the output of v.d.u. memory settling - a process which might take up to two-thirds of a character period - memory

Continued on page 64


Dot clock (IC_{307}, pin 6)
Character clock (IC_{318}, pin 12)
$\overline{CARRY}$ (IC_{318}, pin 7)
Display cycle begins
Character 0 latched
Load shift reg. with char. 0, character 1 latched
Load shift reg. with char. 1, character 2 latched
HD6845 'M' address lines
Address 0
Address 1
Address 2
R/WM outputs
VDU R/WM data 0
VDU R/M data 1
VDU
IC_{315} (latched data) outputs
VDU R/WM data 0
VDU R/WM data 1
Character generator outputs
Char. gen. data 0
Shift register output (IC_{307}, pin 13)
X
0/0
0/1
0/2
0/3
0/4
0/5
X ≡ don't care 0/0 ≡ character zero / bit zero etc.
Display enable timing (IC_{307}, pin 9)
Skewed DISPTMG signal becomes active
Display enabled

VDU timing. Synchronization in this v.d.u. using 'pipelining' (see text) is critical and depends on two signals — NOT CARRY and the dot clock.



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When manufacturers' recommended Fast Programming Algorithms can be used. GANG-OF-EIGHT IS FIVE TIMES AS FAST AS A STANDARD PROGRAMMER. This means you can program a set of 27128's in 2 minutes — not 14 minutes. Or 2764's in 1.25 minutes instead of 7 minutes.

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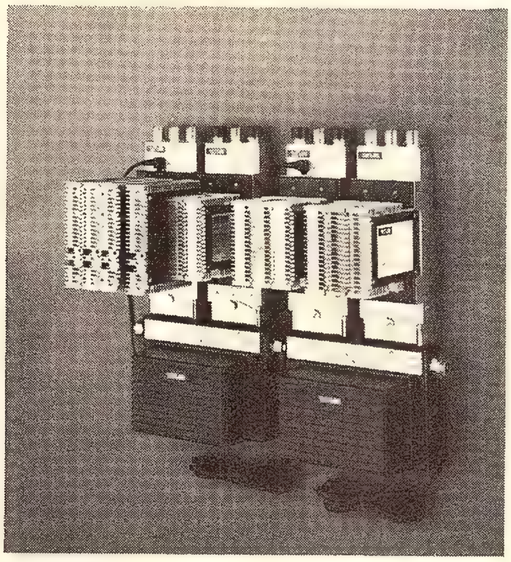
CIRCLE 58 FOR FURTHER DETAILS.

CABLE T.V. HEAD END AND REPEATER AMPLIFIERS



SINGLE CHANNEL AUTOMATIC GAIN CONTROL AMPLIFIERS

TAG4863	Gain 48dB, maximum output 63dBmV. Regulator + or − 8dB. Power requirement 14V 210mA.
TAG4063	Gain 40dB, maximum output 64dBmV. Regulator + or − 16dB. Power requirement 14V 210mA.

SINGLE CHANNEL AMPLIFIERS

TSS4663	Gain 28-46dB adjustable. Maximum output 63dBmV. Power requirement 14V 170mA.
TSS3062	Gain 12-30dB adjustable. Maximum output 62dBmV. Power requirement 14V 26mA.

DRIVER AMPLIFIERS

TS1030FM	FM driver amplifier. 10dB Gain. Maximum output 30dBmV. Power requirement 14V 10mA.
TS1030B3	Band III driver amplfier. 10dB gain. Maximum output 30dBmV. Power requirement 14V 10mA.
TS1030UHF	UHF driver amplifier. 10dB gain. Maximum output 30dBmV. Power requirement 14V 10mA.
TS1040S	Single channel UHF driver amplifier. 10dB gain. Maximum output 40dBmV. Power requirement 14V 10mA. (Quote channel required).

DISTRIBUTION AMPLIFIERS

TE2042	Domestic distribution amplifier. 1 input, 1 output. Gain 20dB. Maximum output 42dBmV.
TE1638	Domestic distribution amplifier. 1 input, 2 outputs. Gain 16dB. Maximum output: 2 at 38dBmV.
TS2046	40-860MHz. Gain 20dB UHF. 18dB VHF. Maximum output 46dBmV.
TS2846	40-860MHz. Gain 28dB UHF, 22dB VHF. Maximum output 46dBmV.
TS2845	Separate UHF/UHF inputs. Gain 28dB UHF, 22dB VHF. Maximum output 46dBmV.
TS2054	40-860MHz. Gain 20dB UHF, 18dB VHF. Maximum output 54dBmV.
TS2060	40-860MHz. Gain 20dB UHF, 18dB VHF. Maximum output 60dBmV.
TS5565	Gain 55dB UHF, 55dB VHF, 42dB FM. Maximum output 65dBmV.

REPEATER AMPLIFIERS

TSC3660	Repeater. Gain 16-36dB UHF, 10-30dB VHF. Maximum output 60dBmV.
TSC3665	Repeater. Gain 16-36dB UHF, 10-30dB VHF. Maximum output 65dBmV.
TSC3060	Repeater. Gain 10-30dB VHF. Maximum output 60dBmV.

CHANNEL CONVERTERS

TCUU	UHF-UHF Single channel converter. Gain adjustable +2dB−16dB. Maximum output +26dBmV. Crystal controlled oscillator. Power requirement 14V 25mA. (Quote Channels required).
TCUV	As TCUU except UHF to VHF converter. (Quote Channels required).
TCVU	As TCUU except VHF to UHF converter. (Quote Channels required).

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SPECIFICATION
HC 6010 DIGITAL

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- ★ Battery: Single 9V PP3. Life: 200 hrs.
- ★ Dimensions: 170 × 89 × 38mm
- ★ Weight: 400g inc. battery
- ★ Mode Select: Push Button
- ★ AC DC Current: 200μA to 10A
- ★ AC Voltage: 200mV to 750V
- ★ DC Voltage: 200mV to 1000V
- ★ Resistance: 200Ω to 20MΩ
- ★ Input Impedance: 10MΩ
- ★ Display: 3½ Digit 13mm LCD
- ★ O/load Protection: All ranges
- ★ Accuracy: 0.5% DC Volts

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HC 6010
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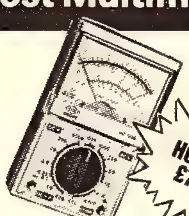

SPECIFICATION
HC1015 ANALOGUE

- ★ DC Voltage: 0.25, 2.5, 25, 250, 1,000 Volts, 10,000 Ohms/Volt
- ★ AC Voltage: 10, 50, 250, 1,000 Volts, 4,000 Ohms/Volt
- ★ DC Current: 1, 10, 500mA
- ★ Resistance: 0 to 1 MegOhm in 3 ranges
- ★ Decibels: −20dB to +62dB
- ★ Battery: One 1.5V size AA (incl)
- ★ Size & Weight: 105 × 63 × 32mm; 130gr

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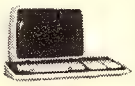

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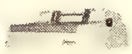

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CIRCLE 57 FOR FURTHER DETAILS.

Improving colour television decoding

by D.C.A. Read, B.Sc. (Eng), M.I.E.E.

Viewing tv pictures at work and at home over several years using various decoding methods, David Read found the comb filter method an undoubted improvement with a 26in screen. But inprovements to other video processing blocks are needed to fully appreciate the picture. This postscript recommends an acoustic surface wave filter for i.f. use and discusses other picture enhancement techniques.

Most of the signal-processing improvements that the home viewer can make — to PAL decoding, RGB drive, and wide-band comb filtering — have been covered in this series of articles. One remaining area for investigation is the tuner/i.f. strip. Although the ten-years old design originally described in these pages (1975, Oct-Dec) is still in use and gives good results, particularly with extended comb filter methods of PAL decoding, it is felt that the design and circuit board cannot be recommended for building today — with discrete inductors providing all the i.f. bandwidth shaping and post-demodulator group-delay equalization. It has been remarked that the board looks more like a Manhattan sky line! There is also a daunting setting-up procedure.

Recently, both Signal Technology and Mullard have been manufacturing some excellent surface acoustic wave i.f. filters. The SD155 from signal Technology is flat at frequencies above f_{sc} and has a sound shelf of —16dB though probably not sufficiently down for a single-chip demodulator e.g. TDA 3541, though an LC trap to provide an extra 10dB could readily be added. Over the retailers' counter this could cost £40 to £50 currently, but it is hoped that cable-head companies and set manufacturers will start to use these better quality filters and the price will reduce.

Some of the better filters, for example Signal Technology's SY155 and RW153P have the subcarrier equivalent frequency (vision carrier minus subcarrier, 35.07mHz), only 0.5 to 2dB down. These will provide the best overall performance with modified LC filters used before the chroma decoder. However, the performance is not good enough to justify the Fig.34 comb filter circuit approach although a much improved picture can be obtained with the alternative LC networks shown last month. This is achieved by using the Fig.77 circuit for the luminance path (Figs 74 and 76 show amplitude and group-delay performance) and the Fig.81 circuit for the chroma path (Figs 79 and 80 give amplitude and delay performance).The chroma circuit can be modified to advantage as shown in Fig.93 (See Figs 94 and 95 for amplitude and delay performance). The modified chroma filter will offer a better chroma bandwidth and reduced 7.8kHz twitter at the chroma transitions if it is adjusted to match the s.a.w. filter response (chroma sideband symmetry optimized), as was similarly indicated in Fig.82.

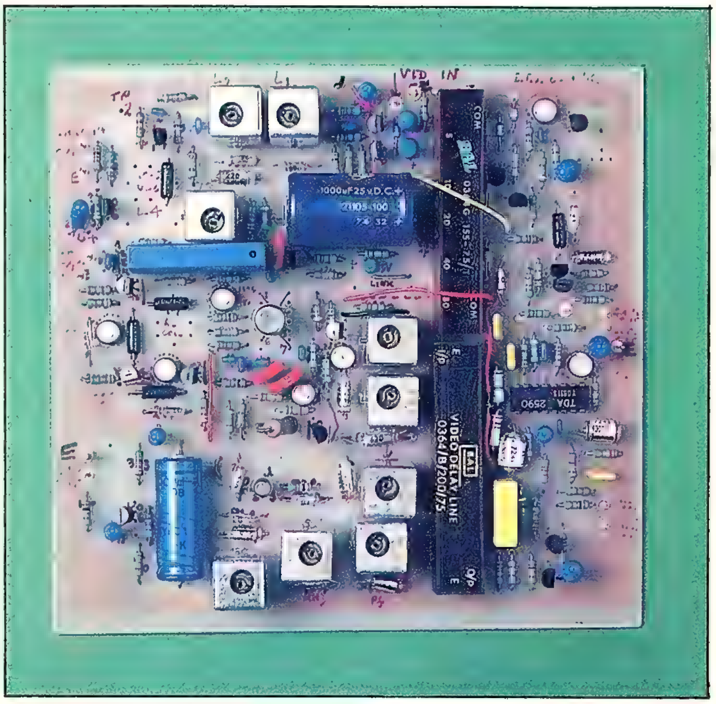
When the s.a.w. filter with the performance of Fig.96 is in use, e.g. the SD155, the best chroma filter is the gaussian band-pass filter of Fig.34. For this Fig.52 shows the amplitude response and Fig.53 the group delay performance, with Fig.52(b) indicating the clean chroma transitions that can be obtained.

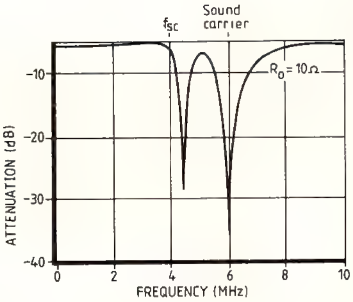
Mullard are expected to introduce two new tuners later this year, the U343 for potentiometer tuning and the U344 for use with a frequency synthesizer. These use low noise, high dynamic range mosfet stages and include the first i.f. bandpass coupling stage and driver amplifier for the s.a.w. filter. The tuner i.f. board then need only comprise a front-end tuner, s.a.w. filter and the integrated i.f. amplifier demodulator TDA3541 together with a few discrete components (ref.11).

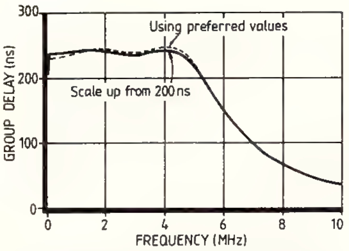
Design of high-grade receiver

For really high quality sound and vision to feed into a comb-type decode, the B.B.C. have designed a u.h.f. tv receiver type RCI/511, being manufactured under licence by SPT Video

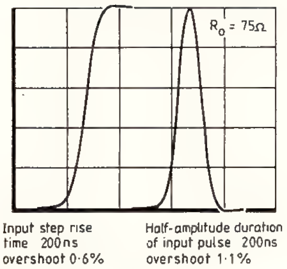
Fig.90. **Board contains PAL modifier and comb luminance filter of Fig.34 together with the optional sync separator sandcastle pulse generator and extra field blanking of Fig.36.**







Errors caused by rounding components of Fig.87 (bottom circuit) to preferred values are shown by the group delay response above (Fig.88).



Group delay ripple and other losses in performance caused by using preferred capicitor values are shown in these pulse-and-step test results (Fig.89).

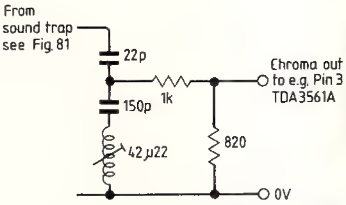

From sound trap see Fig. 81
22p
150p
1k
42µ22
820
Chroma out to e.g. Pin 3 TDA3561A
0V

Fig.93. **Circuit of modified chroma-path filter when using the better i.f. s.a.w. filter. Subcarrier (equivalent frequency 35.067MHz) is only 0.5 to 2dB down.**

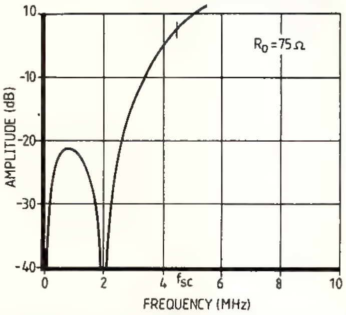


Fig.94. **Amplitude performance of the chroma path filter.**

Limited. This unit has a performance specification of

- Two video outputs at 75Ω: amplitude response ±1dB to 5.5MHz.
- balanced and unbalanced sound outputs: harmonic distortion 0.5% MAX.
- u.h.f. coverage: channels 20-70
- differential phase and gain: 4° and 4% max, 2° and 2% typically.

Physically, it is a 2U high, full bay width unit. Channel setting (tuning) is by front-panel thumbwheel switches which control a synthesiser; a rear D-plug enables remote control. Details of the internal operation are shown in Fig.97; the notes on this block diagram explain the functions.

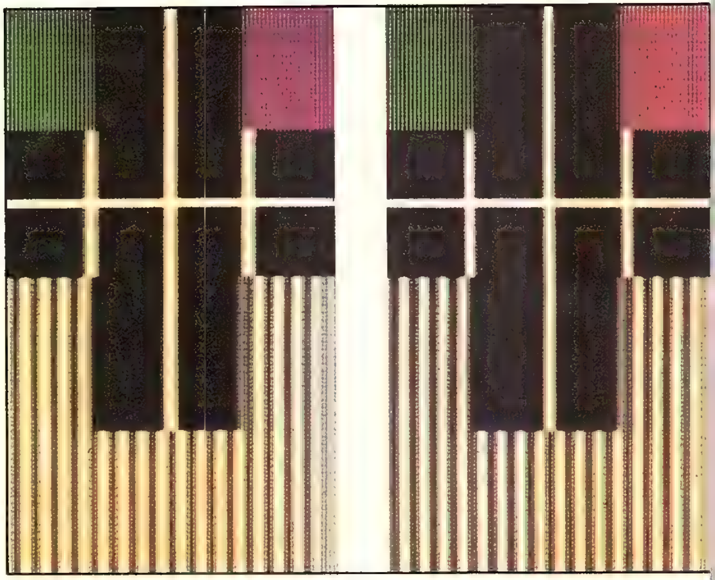


Fig.100. **Resulting picture improvement with scan-velocity of and on (screen photographs taken from a Mullard report)**

Other methods of picture enchancement

There are excellent picture enhancers that rely on picture storage and can provide both horizontal and vertical aperture correction. By recycling the information taken from the picture store with new pictures as they arrive, noise reduction is achieved. But on movement, zonal adaptive techniques are needed to stop cumulative recycling and thus prevent excessive blur.

For the domestic receiver, a simple enhancement technique is to modulate the line scan velocity

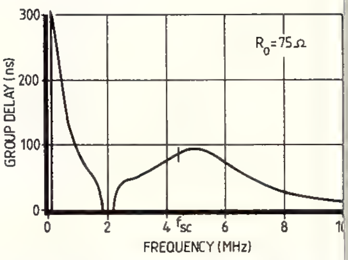


Fig.95. **Group delay response of the high-pass chromafilter.**

Fig.91. **Alternative self-contained decoder board (Fig. 34 & 36 circuits not used) incorporates TDA3561A with the luminance notch filter of Fig.77 and the chroma high-pass filter of Fig.81, hard-wired at the p.c. board edges. Board also has copper tracks laid out for RGB output stages, if needed for video processing improvement, similar to that in the TX10 receiver (Fig. 41, May issue). Boards available from?**

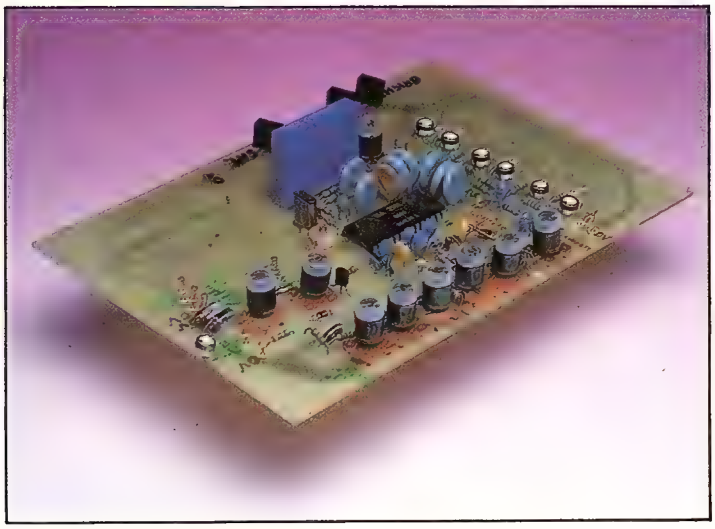
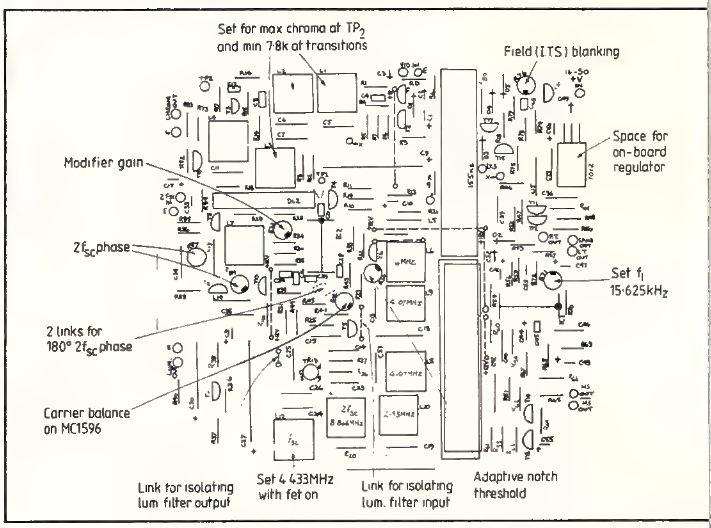
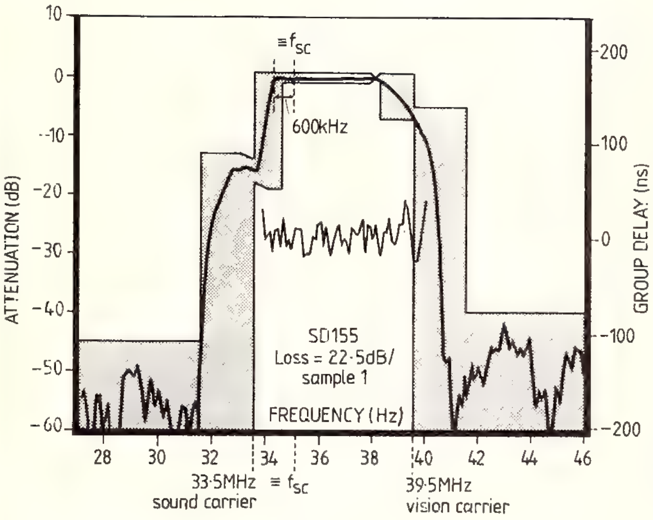


Fig.92. **Component location for PAL modifier comb filter board. It is useful to check the coil bases with the board before winding any coils, particularly the center-tapped ones. Chip provides additionally the 2_{fsc} feed required by the PAL modifier in Fig.34. The sandcastle pulse to the TDA3561A can be supplied from the TDA2591/2/3. These two signals may already be available in existing receiver designs, but check that it is a 2_{fsc} locked oscillator if this signal is to be extracted.**


Set for max chroma at TP_2 and min 7·8k at transitions
Field (ITS) blanking
Modifier gain
Space for on-board regulator
$2f_{sc}$ phase
Set f_1 15·625kHz
2 links for 180° $2f_{sc}$ phase
Carrier balance on MC1596
Link for isolating lum filter output
Set 4.433MHz with fet on
Link for isolating lum. filter input
Adaptive notch threshold



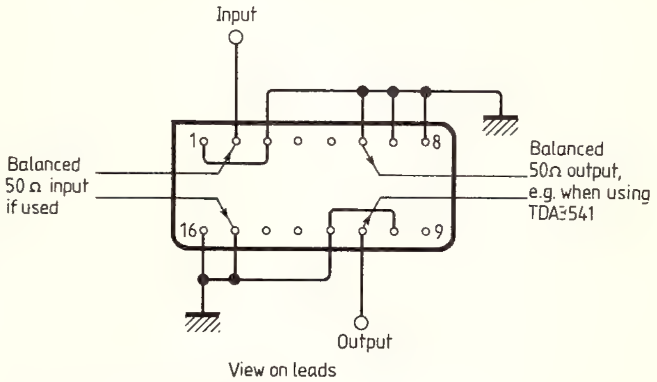
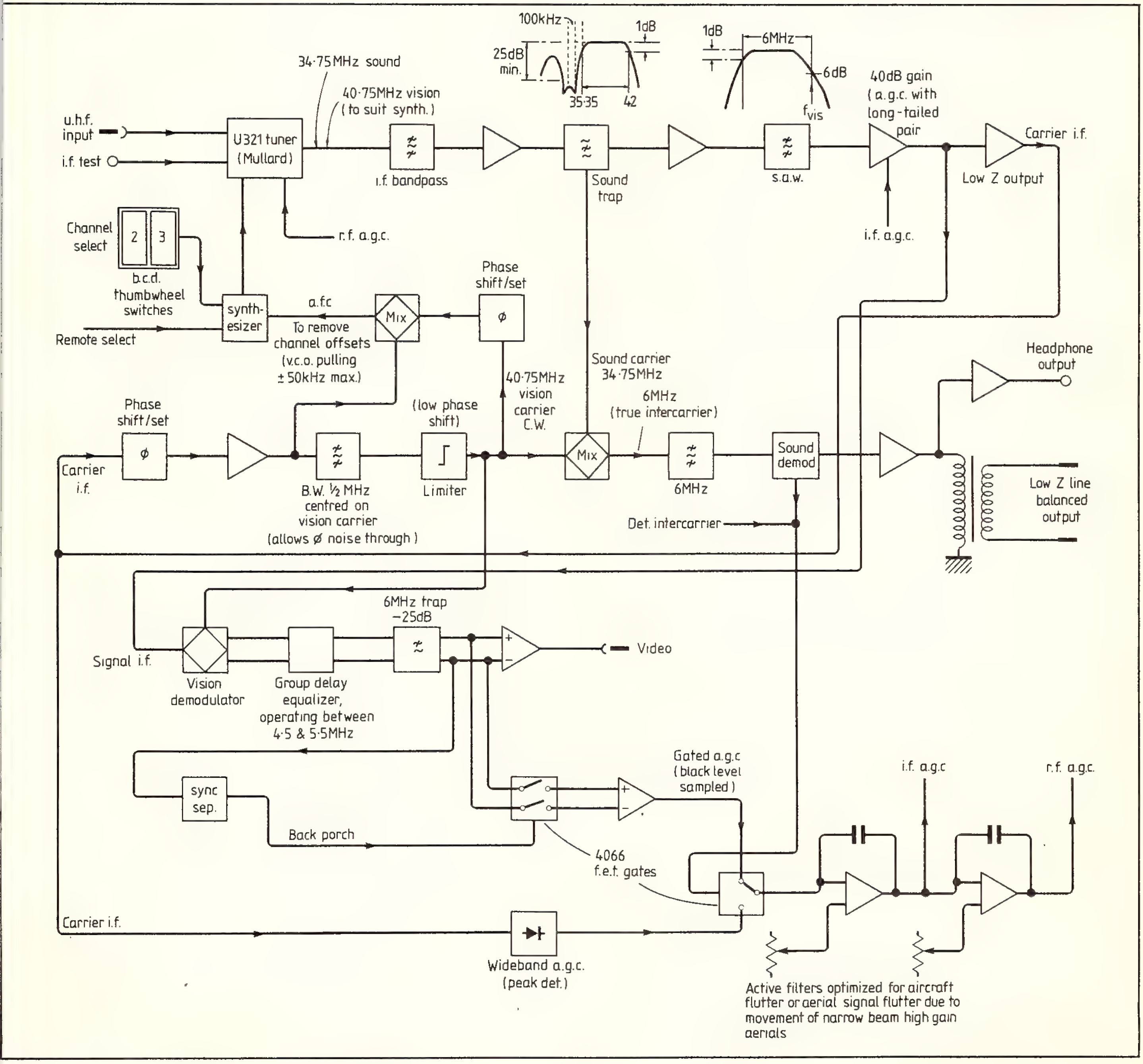

Input
Balanced
50 Ω input
if used
1
8
16
9
Balanced
50Ω output,
e.g. when using
TDA3541
Output
View on leads

Fig. 96. **Amplitude and group delay performance of s.a.w. filter recently introduced by Signal Technology.**

Fig. 97. **Block diagram of the BBC-designed u.h.f. tv receiver, RC1/511, giving outputs of 1 volt composite video and good quality sound.**


100kHz
25dB
min.
35·35
42
1dB
1dB
6MHz
-6dB
f_vis
34·75MHz sound
40·75MHz vision
(to suit synth.)
u.h.f.
input
i.f. test
U321 tuner
(Mullard)
i.f. bandpass
Sound
trap
s.a.w.
40dB gain
(a.g.c. with
long-tailed
pair
Carrier i.f.
Low Z output
r.f. a.g.c.
i.f. a.g.c.
Channel
select
2
3
b.c.d.
thumbwheel
switches
Remote select
synth-
esizer
a.f.c
To remove
channel offsets
(v.c.o. pulling
± 50kHz max.)
Mix
Phase
shift/set
φ
40·75MHz
vision
carrier
C.W.
Sound carrier
34·75MHz
6MHz
(true intercarrier)
Headphone
output
Phase
shift/set
Carrier
i.f.
B.W. ½MHz
centred on
vision carrier
(allows φ noise through)
(low phase
shift)
Limiter
Mix
6MHz
Sound
demod
Det. intercarrier
Low Z line
balanced
output
6MHz trap
−25dB
Signal i.f.
Vision
demodulator
Group delay
equalizer,
operating between
4·5 & 5·5MHz
Video
sync
sep.
Back porch
Gated a.g.c
(black level
sampled)
4066
f.e.t. gates
i.f. a.g.c
r.f. a.g.c.
Carrier i.f.
Wideband a.g.c.
(peak det.)
Active filters optimized for aircraft
flutter or aerial signal flutter due to
movement of narrow beam high gain
aerials

Readers of this series puzzled by the numbering of component references on page 33 of the May installment may be reassured to know that it originated from the maker's service sheet and were not shown on the circuit diagram.

The BC337s of Fig.41 are transistors 653, 652 & 651 in the text, the BF392s are 659, 658 & 657, and resistors 665, 664 & 663 are the 22k pull-up components at the BF392 bases. Also on that page, the resistor referred to in line three, column three, should be 2.7k and not 2.7Ω In Fig.42, the annotation 'Fig.34' should have read Fig.41. The author also asks us to point out that in Fig.40 the chroma input burst should be 150mV rather than the 250mV shown at pin3 of the i.c.

The right-hand ordinate on Fig.86 (page 62, June) was inadvertently cropped, and should of course be labelled with attenuation in dB. Observant readers will have noticed that Fig.60 was a repeat of Fig.69; the correct figure appears in this article. In Fig.24 (page 56 January) please substitute 200ns for the 200μs shown.

Component suppliers

1. Surface wave filters
Signal Technology Ltd, Crompton Road, Groundwell Industrial Estate, Swindon. Wilts.
Tel: 0793-726666 ex. 230.

Mullard Ltd,
Torrington Place, London WC2.
Tel: 580-6633.

Delay lines.
Manor Supplies, 172 West End Lane, London NW3.
Tel: 794-8751.

Future Films
Leamington Street, London W1.
Tel: 437-1892.

Coil formers
Cirkit (Ambit), 200 N.Service Road, Brentwood, Essex.
Tel: 0277 231616.

Parts list for Fig.34,36 one-line comb filter circuits.

Capacitors. Polystyrene ±2% 125V (Suflex, Salford, Lemco)

Value (F)	Circuit reference
220p	13, 7, 24, 36
39p	5
56p	6
620p	18
100p	51, 39
680p	19
150p	20
82p	26, 23
270p	25
27p	34, 35
62p	37
4.2n	46

Disc ceramic or red/blue cap.

10n	4, 8, 12, 16, 21, 45, 48
1n	28, 29, 33
100n	32

Polyester metallized ±10% 100 or 250V (Mullard type 344)

6.8n	40
470n	42
270n	53

Tantalum ±20% (Union Carbide or RS components)

30μ 10V	1, 2
22μ 15V	3, 17, 31, 30, 22, 47, 55
22μ 10V	10
4.7μ 25V	44

Electrolytic (Eire, Mullard or equivalent)

1m 6.3V	27

Transistors

Type	Circuit reference
2N3904 BG239	1, 3, 8, 9, 10, 11, 12
2N3906 or BC309	2, 4, 6, 18, 5, 18 (reference missing from the circuit: transistor with R36, 38), 13, 14, 15, 16, 17
or VN0610L, or VN2222L, or M991BD/C, or 1167BD	TR19 (f.e.t.)

Integrated circuits

MC796, MC1496 or MC1596 IC_2
TDA2590/1/2/3
IC_1
TDA2593 in the current I.C.
If used +12V regulator μA7812

Diodes

BZY88C6V2	D_1, D_4
BZY88 C4V3	D_5
1N916	D_3

Delay lines

DL_1 Best to make the descrete LC network $Z_0$220Ω or see text for alterations.

DL_2 DL60 or DL700 not critical. Observe R_{18} and R_{28} suit Z_O of line. See table

Resistors. Mullard MR25 metal film ±2% 0.4W or equivalent metal film ±5% 0.2W.

Value(Ω)	Circuit reference
4.7k	1, 3, 57
470Ω	12, 16, 31, 33, 81
13kΩ	10
10kΩ	13, 15, 47, 63, 74
560Ω	21, 18, 28
150Ω	23, 37
1k	22, 4, 5, 46
680Ω	8, 73, 36
27k	14, 85
100Ω	83, 34, 64, 65
3.3k	82, 38, 86, 88, 90, 66, 79
100k	26, 40
33k	29, 30, 54, 75 (note R_{29} was 22k, R_{30} was 18k using 33k improves modifier balance)
22k	84, 45, 80
12k	41, 49, 69
20k	43 (use 2×10k or 18k if necessary)
15k	44
2.7k	48
2.2k	50, 61, 62
1.5k	52
2.2M*	60 Eire carbon ±5% 0.33W
1.8M*	59 Eire carbon ±5% 0.33W
1.2k	67
82k	68, 55
120k*	70 Mullard MR30 metal film or equivalent ±5% 0.25W
220Ω	53, 56
47k	58, 78
220Ω	72
47	51
1.6k	to pin 5 MC796 (Fig.34) from ±12V rail (component ref. omitted from circuit)
R_D	R_2 and R_D can be set as a potential divider to suit higher video input levels. If high Z in required omit R_2 and set R_D to 470Ω (parasitic oscillation stopper)

Potentiometers (Cermet)

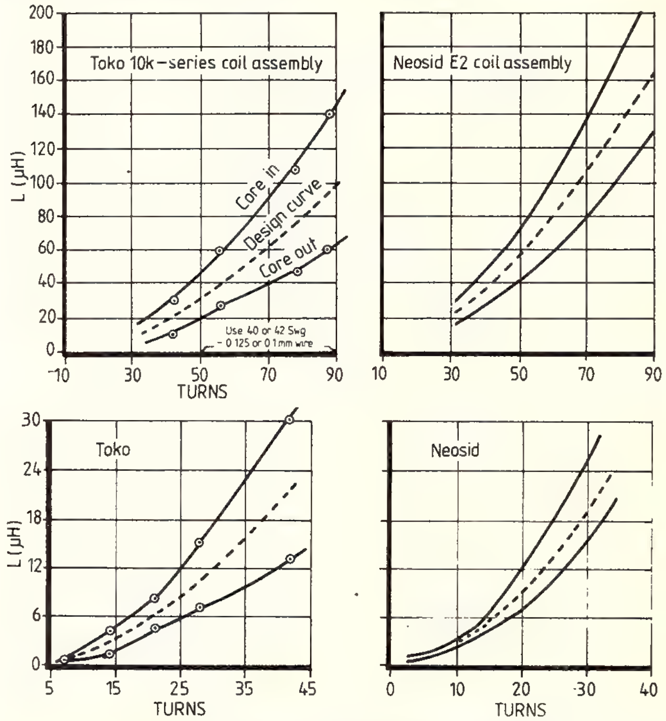
Value	Circuit reference
500Ω	24
1k	32
5k	42, 89
10k	87
100k	76
50k	71

Values determined by DL_1 impedance

Zo	75Ω	800 - 1kΩ	using LC network 220Ω
R_6	150Ω	1.6kΩ	440Ω (2×220)
R_7	150Ω	1.6kΩ	440Ω (2×220)
R_9	120Ω	—	—
R_{11}	220Ω	820Ω	220Ω
R_{17}	68Ω	150Ω	68Ω
R_{19}	1kΩ	2.7kΩ	1kΩ
R_{20}	510Ω	1.5kΩ	510Ω
C_9	1mF	—	—

Circuit reference	Value		Turns Neosid E2	Toko
1	33μ	Set for max, chroma &	37	55
2	23μ	min. 7.8kHz at transitions	34	42
3	5.4μ		15	18
4	10.5μ	Set for max. chroma, not critical	21	27
5	10μ	Painton or Sigma choke		
6	6μ	Set to notch fsc.	16	21
7	9.7 or 10μ	Painton or Sigma choke	20½	26
8*	14.3μ	resonate top L_8 to 4.07MHz one end of C_{18} removed.	13TBIFILOR (13.0.13)	16TBIFILOR (16.0.16)
9*	2μ4μ	Resonate L_9 with C_{18} connected & short the outer pins of L_8 together.	10	13
10*	16.6μ	Disconnect output end of L_{10}, series resonate the remaining half-coil with the 680pF at 2.93MHz (or use wider signal-bar corner on i.t.s.).	14BIFILOR (14.0.14)	18TBIFILOR (17.0.17)
11	3.8μ	not 3μH as shown in circuit. Resonate at $2f_{sc}$.	13½	16
12	5μ1μ	Set for filter cut-off. — Not critical.	15	18
13, 14	22μ	Painton or Sigma choke		
15	150μ	150μ Painton or Sigma choke		

*It is best to set up A and B group-delay equalizer sections in isolation, i.e. no other equalizer or filter component in the circuit; thus check each stage of the filter and equalizer one section at a time.
L_8 and L_{10} measured across outer pin i.e. total inductance.



in relation to transitions in the increasing video signal. A pair of four-turn coils built into the scanning yoke and placed in the line-scan coil plane provides line aperture modulation of the scanning field. A restricted spectrum of the luminance signal (in the range 2 to 3.5MHz) is amplified, amplitude-limited and used to drive the extra coils in the scan yoke. The block diagram is shown in Fig.98. The additional circuit feeding these coils need only consist of a simple CR differentiator, back-to-back diode limiter and class B output amplifying transistors. The waveforms of the system are as shown in Fig.99 and the display picture shown in Fig.100 illustrates 'before and after' the application (screen photograph taken from a Mullard publication).

Picture enhancement with colour-transient improvement circuit

It is possible to improve the R G B signal where the chroma bandwidth has been restricted to suppress crosscolour, resulting in risetimes in excess of 500ms. On improving (speeding up) the risetimes, care has to be taken not to exaggerate the crosstalk (e.g. increased U/V 12.5Hz flicker).

By using a switched equalizer under the control of the differentiated luminance signal (to minimize cross-colour increase), the U and V i.e. B—Y and R—Y chrominance steps can be improved. This is possible because of the good correlation between the luminance and chrominance picture information. An i.c. to improve colour transients is the Mullard TDA4560, shown in Fig.101. This uses the differentiated input R—Y and B—Y chroma to control and chroma delay switching. The effect of using such techniques is for a chroma positive-going transition as seen in Fig.102.

Picture enhancement techniques and various methods of aperture correction can have adverse effects - multiple images and movement blur - viewers have said that the picture appears as if looked at through speckled glass. Also if the noise spectrum lies in the 2-3MHz region, noise on the final picture can be increased. After viewing many live programmes it was concluded that it is better to get back more of the signal as originally generated at source.

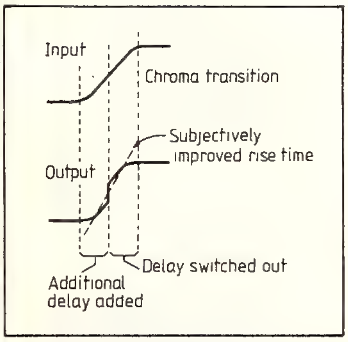


Fig.102. **Waveforms showing chroma edge enhancement by delay switching.**

REFERENCES

1. Drewery, J.O. Filtering of Luminance and Chrominance Signals to Avoid Cross-colour in PAL Colour System. BBC Research Department Report 975/36. See also *BBC Engineering* 1976.
2. Mullard Limited, Mullard House, Torrington Place, London WC1E 7HD. Scan Velocity Modulation for the 30AX Tube.
3. Fischer, T. Digital v.l.s.i breeds next generation tv receivers. *Electronics* 11 Aug. 1981
4. Reitmeier, G.A. "The Effects of analog filtering on the picture quality of component digital television systems. *SMPTE Journal* Oct. 1981.
5. Auty, Read & Roe, Colour picture improvement using simple analogue comb filters. *BBC Engineering* Dec.1977 no.108 pp.28-33. Also *SMPTE Journal* Oct.1978 vol.87.
6. Clarke, C.K.P. Digital standards conversion: Comparison of colour methods. BBC Research Department Report 1972/6.
7. J. Sabatier and F. Kretz. Sampling the components of 625-Line television signals. *EBU Review,* no.171 Oct.1978.
8. G.D. Roe and D.C. Read Patent 2256/77 Comb Filters for PAL Coders and Decoders. Nov.1977, UK patent 2256/77.
9. C.K.P. Clarke, 1982. High Quality Decoding for PAL inputs to digital YUV studios. BBC Research Department Report 1982/12.
10. P.G.J. Barten and J. Kaashoek. 30AX Self-aligning 110° In-line Colour TV Display. Mullard Technical Note 119.
11. P.J.M. Sijbers and J. Zeelen (Philips Technical). One i.c. and a SAW-filter in a high-performance vision i.f. channel. *Electronic Components and Applications.* vol.5, no.1. Nov.1982.
12. A. Oliphant, 1982. Weston Clean PAL BBC Research Department Report. 1980/1.

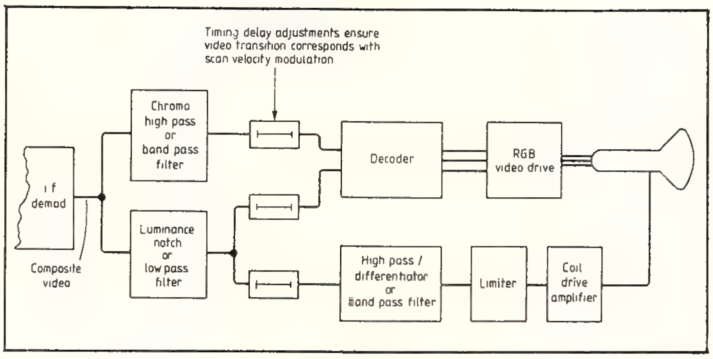

Timing delay adjustments ensure video transition corresponds with scan velocity modulation
Chroma high pass or band pass filter
Decoder
RGB video drive
i f demod
Composite video
Luminance notch or low pass filter
High pass / differentiator or band pass filter
Limiter
Coil drive amplifier

Fig. 98. **Block diagram describing a method of scan-velocity modulation to improve picture sharpness.**

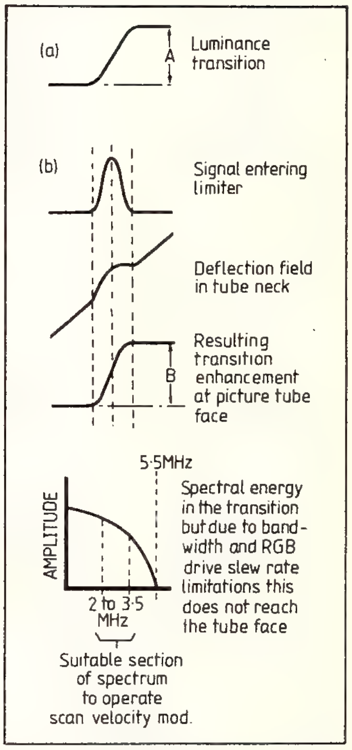


Fig.99. **Example of waveforms occurring in a scan-velocity modulation circuit.**

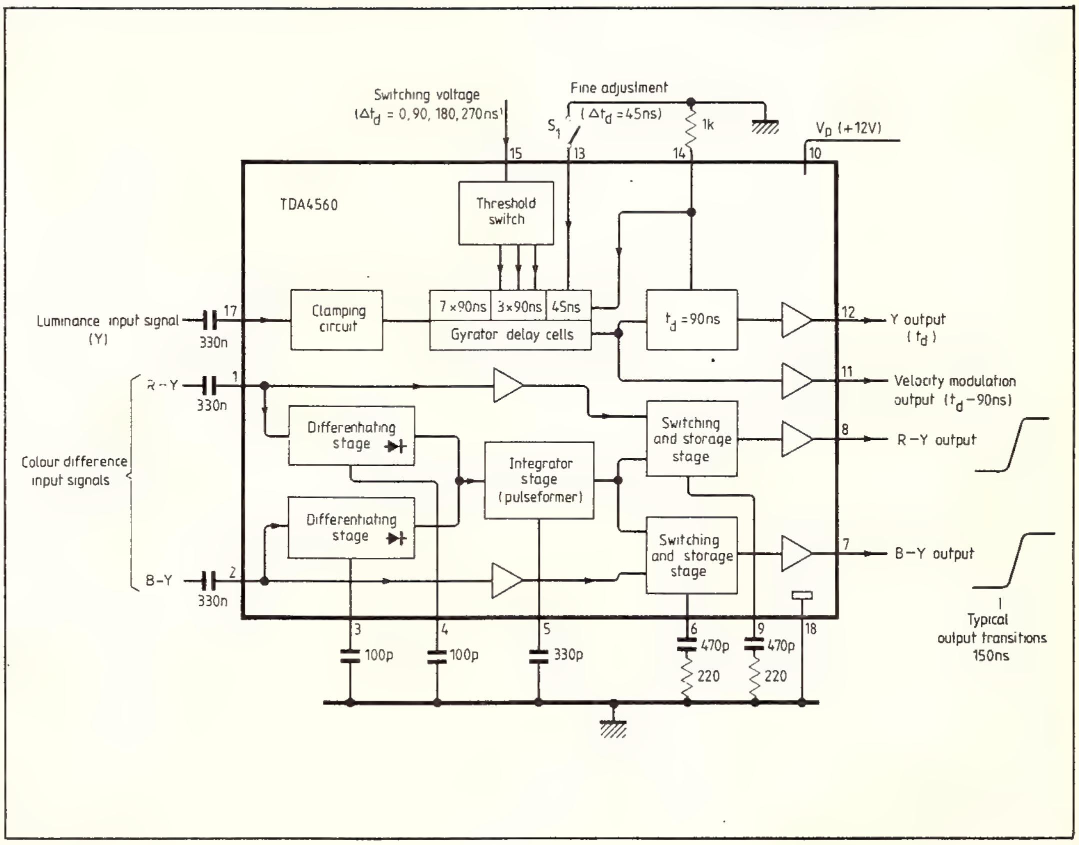

Switching voltage
(Δt_d = 0, 90, 180, 270ns)
Fine adjustment
(Δt_d = 45ns)
S_1
1k
V_p (+12V)
15
13
14
10
TDA4560
Threshold switch
7×90ns
3×90ns
45ns
Gyrator delay cells
t_d = 90ns
Luminance input signal (Y)
17
330n
Clamping circuit
12
Y output (t_d)
11
Velocity modulation output (t_d − 90ns)
R−Y
1
330n
Colour difference input signals
Differentiating stage
Integrator stage (pulseformer)
Switching and storage stage
8
R−Y output
Differentiating stage
Switching and storage stage
7
B−Y output
B−Y
2
330n
3
100p
4
100p
5
330p
6
470p
220
9
470p
220
18
Typical output transitions 150ns

Fig.101. **Functional block diagram of an available i.c. for colour transient improvement (taken from the data sheets for the TDA4560).**

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6000	228.75	OA

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2		1	4.25	1.20
4		2	4.91	1.60
6		3	7.69	1.60
8	A	4	8.98	1.60
10	M	5	9.82	1.80
12	P	6	10.89	1.90
16	S	8	12.97	2.12
20		10	17.46	2.44
30		15	21.69	2.64
60		30	44.45	OA
83		41	51.20	4.50

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Secs 2×36/48V

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5	P	10	32.23	3.20
6	S	12	40.36	3.50
8		16	44.03	3.75

50/25V or 25-0-25V
2×25V Tap Secs. 5, 7, 8, 10, 13, 15, 17, 20, 25, 30, 33, 40, 20-0-20 or 25 0-25V

50V		25V	Price	P&P
0.5		1	4.13	1.40
1		2	5.03	1.50
2		4	8.69	1.84
3	A	6	10.36	1.90
4	M	8	14.10	2.12
6	P	12	18.01	2.20
8	S	16	24.52	2.70
10		20	30.23	3.00
12		24	36.18	3.20

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4	P	8	15.15	2.20
5	S	10	19.16	2.20
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8		16	30.72	3.00
10		20	35.76	3.30
12		24	41.22	3.50

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9×2	.33×2	2.41	.90
8,9×2	.5×2	3.36	1.20
8,9×2	1A×2	4.27	1.40
15×2	.2A×2	2.41	.90
12-0-12	.05	3.11	.90
20×2	.3×2	3.39	1.20
20×2	.15×2	1.50	.50
20,12,0			
12,20	.9	4.13	1.30
15,20-2	1A×2	5.60	1.60
15,27×2	.5×2	4.83	1.40
15,27×2	1A×2	7.30	1.60

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1		2	4.32	1.40
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4	P	8	9.67	1.90
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8		16	18.10	2.26
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20		40	35.64	4.83

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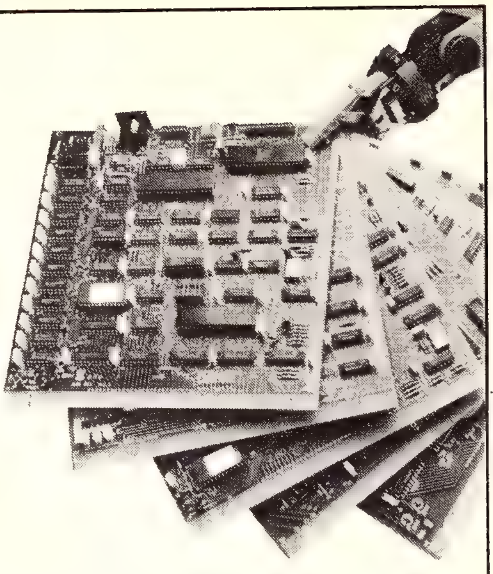

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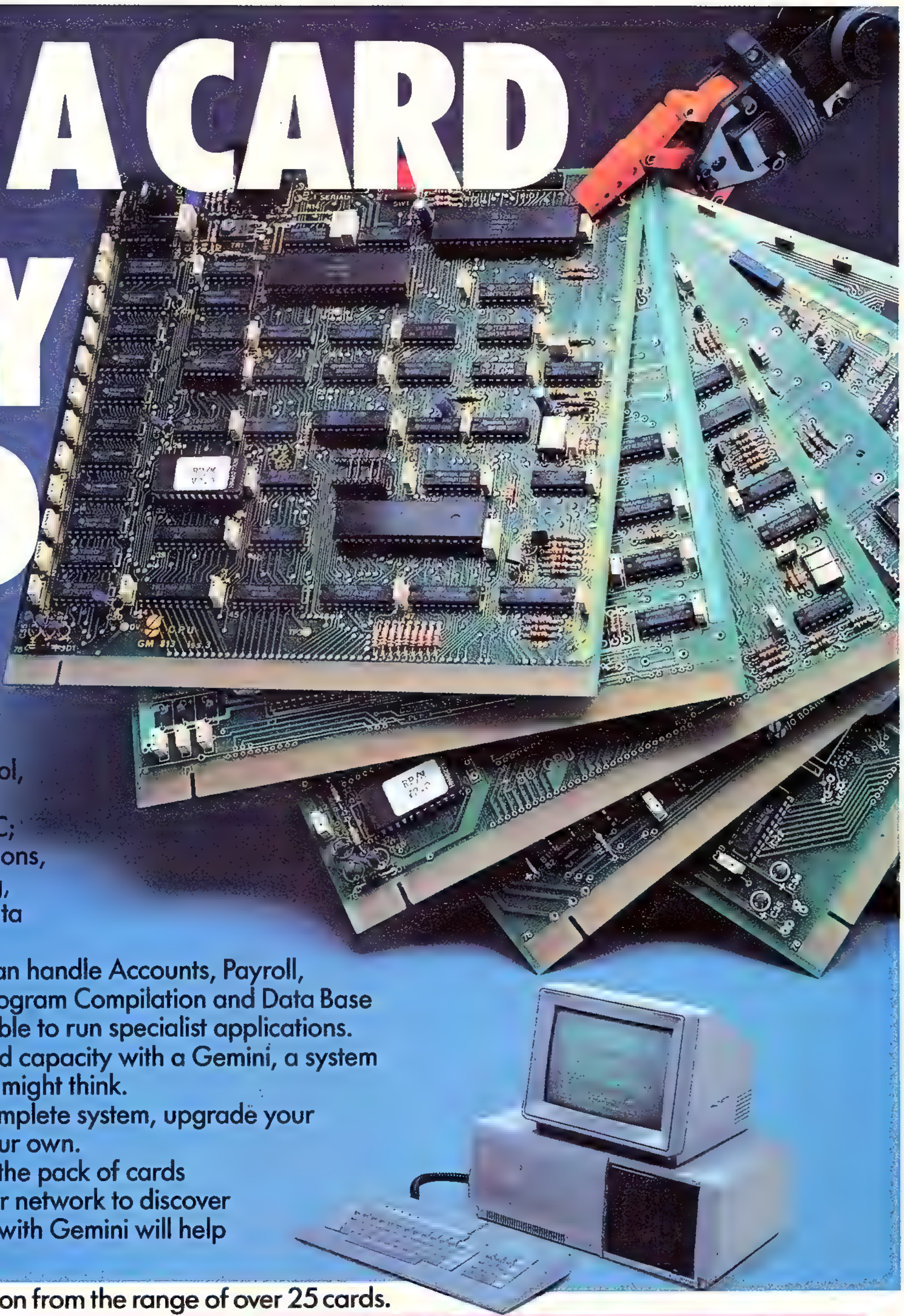

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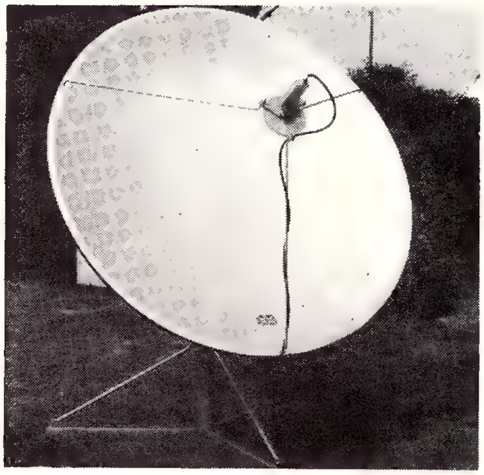
Telephone: KINGSLAND (056881) 744 Telex 837264.

CIRCLE 70 FOR FURTHER DETAILS.

SATELLITE RECEIVING EQUIPMENT



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Dealer enquiries welcome

For further details contact: Harrison Electronics, 22 Milton Road, Westcliff-on-Sea, Essex SS0 7JX. Telephone: Southend (0702) 332338.

CIRCLE 6 FOR FURTHER DETAILS.

Multi-standard modem

by Richard Lambley

Details of the line interface and software requirements, plus some telephone numbers to dial

The line interface follows the pattern shown in Fig.3 of the article in the May issue. In the direct-connect version of the modem, op-amp IC_{10} duplexes the transmitted and received carriers. Resistor R_{44} is the terminating resistor for the telephone line. A cmos analogue switch IC_9 provides loopback of the transmitted signal to the receiver input when S_2 is in test position; but in a direct-connect modem, this i.c. and its associated components (Tr_2 and Tr_3 etc.) should be omitted, since there will be sufficient coupling around the duplexer. If IC_9 is not fitted, a link must be wired between pins 8 and 9 of its location on the p.c.b.

When a call is in progress, the modem holds the telephone line by means of the gyrator network around Tr_5 and Tr_6. This arrangement is taken from a Mullard circuit* widely used in commercial modems. No heat-sink is required for Tr_5. The capacitors in the line interface may have to withstand ringing voltages and transients on the line, and so it is important to fit suitably rated types: for the prototypes, 250V metallized film capacitors were chosen.

If the constructor does not intend to add an auto-dialler, there is no need for RL_2, RL_3 or their associated components R_{49}, R_{51} and C_2; but a wire link should be added in place of the contacts of RL_2.

The spark gap across the telephone line is included for safety, although some commercial modems do without. It should be able to withstand the voltages developed during ringing without breaking down. Suitable types are available from Electrovalue Ltd.

The auto-answer circuit is isolated from the line by an opto-coupler IC_{11}. The zener diodes are to protect IC_{11} against damage by over-voltages and to define a threshold level below which it will not respond. An a.c. ringing voltage causes the level on pin 3 of the inverter (IC_{16}) to fall, triggering the monostable. The telephone will continue to ring for a few seconds until the second monostable is triggered by the rising edge at IC_{16} pin 4.

At this point, pin 1 of the Am7910 is pulled low, causing it to begin its answering sequence, and the line-seize relay RL_1 closes. The time constant of the second monostable is about 30 seconds, which should allow enough time for the calling modem to establish communication. Control of RL_1 then passes to the CD or BCD outputs of IC_8: if the incoming carrier is lost the relay will be released and the call terminated.

To enable auto-answering, it is necessary to disable RTS until the answer sequence of IC_8 is complete. For this reason the amendments shown in Fig.3 should be made to the computer interface section of the modem. The additional connection to pin 16 of IC_8 is to ensure that the DTR signal is removed briefly between auto-answered calls. Without this, the modem will not generate its burst of answer tone.

However, a problem may arise if a large transient occurs on the line as S_3 is moved. The first monostable in IC_{12} may be triggered, removing DTR temporarily. If this happens, a way of dealing with it is to inhibit the monostable except when auto-answering is enabled. Omit C_{40} and R_{58}, but connect pin 6 of IC_{16} to pins 3 and 11 of IC_{12}.

If the components of the auto-answer section are ommitted entirely, a 47kΩ resistor must be inserted between pins 12 and 16 of the IC_{12} position to ensure that pin 1 of the Am7910 is tied high.

Note also that the dotted links LK_{10} and LK_{12} in last month's circuit diagram are shown reversed: if a full RS232 interface is required, the RTS input of IC_8 should be linked to pin 11 of IC_5 and the BRTS input to pin 8 of IC_5.

Components

The Am7910 integrated circuit is stocked by AMD distributors, including Quarndon Electronics and Hawke Electronics; the unit price is £32.80 excluding v.a.t. This and other semiconductor devices for the project together with the crystal, the relays and the connectors are available from Technomatic Ltd (see address list). The Am7910 is also stocked by Maplin Electronics.

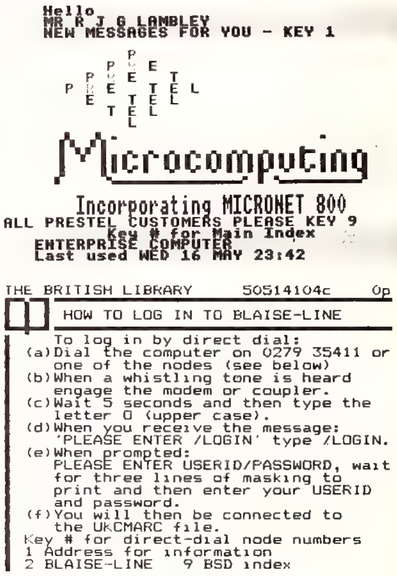
The two transformers can be supplied for £5.70 the pair, including inland postage and v.a.t., by Barrie Electronics.

A printed circuit measuring 160 by 200mm will be available from July 10 from Combe Martin Electronics, for £16 inclusive. The board, a prototype of which was shown in last month's article, is double sided with plated-through holes.

Software

To control the modem, a suitable communications program is needed. In its simplest form, this would configure the serial port to transmit and receive at the required rate. It would then route data arriving from the modem to the screen, and direct data from the keyboard to the modem.

In a practical program there would also be facilities for selecting the data word length, parity and stop bits, for controlling the display format and for transferring disc or cassette files to and from the modem.

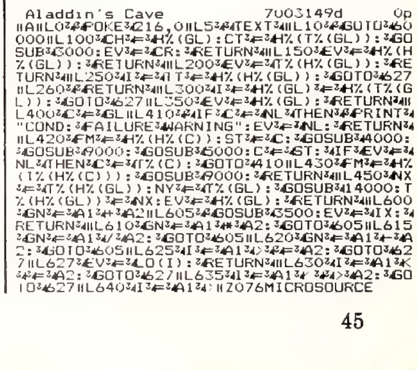


```
Hello
MR R J G LAMBLEY
NEW MESSAGES FOR YOU - KEY 1
          P
       P     E
     P    E     T
   P    E    T  E  L
     E     T  E  L
        T   E  L
          L
      Microcomputing

    Incorporating MICRONET 800
ALL PRESTEL CUSTOMERS PLEASE KEY 9
      Key # for Main Index
   ENTERPRISE COMPUTER
   Last used WED 16 MAY 23:42

THE BRITISH LIBRARY      50514104c     0p
     HOW TO LOG IN TO BLAISE-LINE
     To log in by direct dial:
  (a)Dial the computer on 0279 35411 or
     one of the nodes (see below)
  (b)When a whistling tone is heard
     engage the modem or coupler.
  (c)Wait 5 seconds and then type the
     letter O (upper case).
  (d)When you receive the message:
     'PLEASE ENTER /LOGIN' type /LOGIN.
  (e)When prompted:
     PLEASE ENTER USERID/PASSWORD, wait
     for three lines of masking to
     print and then enter your USERID
     and password.
  (f)You will then be connected to
     the UKCMARC file.
  Key # for direct-dial node numbers
  1 Address for information
  2 BLAISE-LINE    9 BSD index
```

Logging on, or in: like Prestel and many commercial databases, the British Library's BLAISE system asks for passwords.



```
 Aladdin's Cave                 7003149d      0p
‖A‖L0¾◀POKE¾◀216,0‖L5¾◀TEXT¾◀‖L10¾◀GOTO¾◀60
000‖L100¾◀CH¾◀=¾◀H%(GL):CT¾◀=¾◀H%(T%(GL)):¾◀GO
SUB¾◀3000:EV¾◀=¾◀CR:¾◀RETURN¾◀‖L150¾◀EV¾◀=¾◀H%(H
%(GL)):¾◀RETURN¾◀‖L200¾◀EV¾◀=¾◀T%(H%(GL)):¾◀RE
TURN¾◀‖L250¾◀I¾◀=¾◀T¾◀=¾◀H%(H%(GL)):¾◀GOTO¾◀627
‖L260¾◀RETURN¾◀‖L300¾◀I¾◀=¾◀H%(GL)¾◀=¾◀H%(T%(G
L)):¾◀GOTO¾◀627‖L350¾◀EV¾◀=¾◀H%(GL):¾◀RETURN¾◀‖
L400¾◀C¾◀=¾◀GL‖L410¾◀IF¾◀C¾◀=¾◀NL¾◀THEN¾◀PRINT¾◀
"COND:¾◀FAILURE¾◀WARNING":EV¾◀=¾◀NL:¾◀RETURN¾◀
‖L420¾◀FM¾◀=¾◀H%(H%(C)):ST¾◀=¾◀C:¾◀GOSUB¾◀4000:
¾◀GOSUB¾◀9000:¾◀GOSUB¾◀5000:C¾◀=¾◀ST:¾◀IF¾◀EV¾◀=¾◀
NL¾◀THEN¾◀C¾◀=¾◀T%(C):¾◀GOTO¾◀410‖L430¾◀FM¾◀=¾◀H%
(T%(H%(C))):¾◀GOSUB¾◀9000:¾◀RETURN¾◀‖L450¾◀NX
¾◀=¾◀T%(H%(GL)):NY¾◀=¾◀T%(GL):¾◀GOSUB¾◀14000:T
%(H%(GL))¾◀=¾◀NX:EV¾◀=¾◀H%(GL):¾◀RETURN¾◀‖L600
¾◀GN¾◀=¾◀A1¾◀+¾◀A2‖L605¾◀GOSUB¾◀3500:EV¾◀=¾◀IX:¾◀
RETURN¾◀‖L610¾◀GN¾◀=¾◀A1¾◀*¾◀A2:¾◀GOTO¾◀605‖L615
¾◀GN¾◀=¾◀A1¾◀/¾◀A2:¾◀GOTO¾◀605‖L620¾◀GN¾◀=¾◀A1¾◀-¾◀A
2:¾◀GOTO¾◀605‖L625¾◀I¾◀=¾◀A1¾◀>¾◀=¾◀A2:¾◀GOTO¾◀62
7‖L627¾◀EV¾◀=¾◀LO(I):¾◀RETURN¾◀‖L630¾◀I¾◀=¾◀A1¾◀<
¾◀=¾◀A2:¾◀GOTO¾◀627‖L635¾◀I¾◀=¾◀A1¾◀<¾◀>¾◀A2:¾◀GO
TO¾◀627‖L640¾◀I¾◀=¾◀A1¾◀>‖Z076MICROSOURCE
```

The start of a program in Apple Basic, in Prestel telesoftware format. With the help of suitable communications software, a complete program can be down loaded automatically in about the time it would take to load from tape.

---

*LSI circuits for teletext and viewdata: the Lucy generation. Mullard Technical Publication M81-0001, June 1981.

Other useful options include the ability to send Xon and Xoff commands to halt temporarily the output from the distant computer, and to echo incoming characters back to it: this allows the other operator to see what he is typing. There may be some advantage too in redefining the output of certain keys on the keyboard. In particular, the effect of the delete key seems to vary from one computer to another. For Viewdata systems such as Prestel it is convenient to have the return key send a # character.

Some of the bulletin board systems listed here have adopted the so-called Christensen or Xmodem protocol for file handling. This protocol allows virtually error-free transfer of Ascii text or program files over event the poorest lines. The file to be sent is transmitted in 128-byte blocks, with error-checking on each block. If an error arises, the receiving computer asks for the block to be sent once more. Error-checking is used also in viewdata terminal programs for telesoftware file downloading.

Viewdata software for a variety of home and business computers is available from Micronet 800. For the 300 baud modes, Maplin Electronics can provide modem interfaces and software for the ZX81, Spectrum, Dragon, Oric, VIC 20 and Commodore 64.

For the BBC Microcomputer there is a wide choice of software, including packages in eprom. Computer Concepts' communicator (16Kbyte) provides emulation of a DEC VT100 terminal. It gives very extensive control of transmission mode and display format and includes such features as storage of telephone numbers for an auto-dialler. Communicator costs £59.

A rom of especial interest to bulletin-board users is Pace Software's Commstar (8Kbyte). This provides software handshaking, file transfer facilities using the Christensen Xmodem protocols and numerous other features. Current versions have a Prestel mode which supports colour Viewdata graphics (including double-height characters) and can download telesoftware. The price is £34 including v.a.t.

Software for the TRS-80 is available from Molimerx Ltd, who offer two communications packages: Smart Terminal at £25.30 and Modem 80 at £30.48.

A communications program to run under CP/M-80 is available to members of the CP/M User's Group. Details, in return for a stamped addressed envelope, from the group at 72 Mill Road, Hawley, Dartford, Kent. Individual membership costs £7.50 per year.

Logging on

First select the appropriate signalling standard and mode using S_1 and S_2. At this stage S_3 should be in the centre off-line position. Dial up the computer of interest; and when its answering tone is heard move S_3 to the on-line position. This will establish communication, disconnecting the tele-

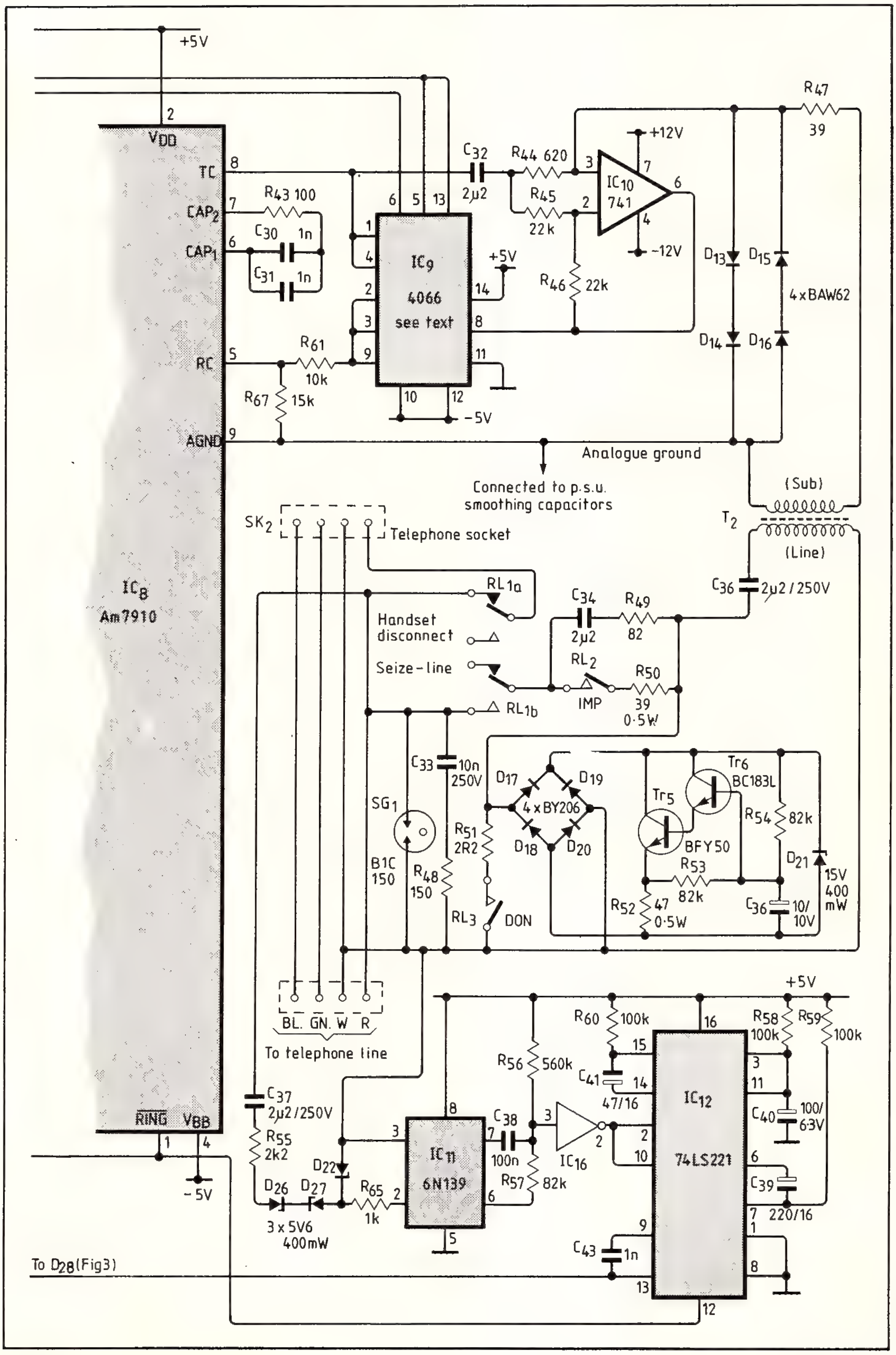


Fig.1. Line interface, and auto-answer section. Isolation from the line is via a transformer and, for the ring detection circuit, an opto-coupler. An auto-dialler could be added by the user if required.

+5V
VDD
TC
CAP2
CAP1
RC
AGND
RING
VBB
IC8
Am7910
-5V
To D28(Fig3)
R43 100
C30 1n
C31 1n
R61 10k
R67 15k
IC9
4066
see text
C32 2µ2
R44 620
R45 22k
R46 22k
IC10
741
+12V
-12V
R47 39
D13
D14
D15
D16
4xBAW62
Analogue ground
Connected to p.s.u. smoothing capacitors
(Sub)
T2
(Line)
C36 2µ2/250V
SK2
Telephone socket
RL1a
Handset disconnect
Seize-line
RL1b
C34 2µ2
R49 82
RL2
IMP
R50 39 0·5W
C33 10n 250V
SG1
B1C 150
R48 150
R51 2R2
RL3
DON
D17
D18
D19
D20
4xBY206
Tr5
BFY50
Tr6
BC183L
R54 82k
R53 82k
R52 47 0·5W
C36 10/10V
D21 15V 400mW
BL. GN. W R
To telephone line
C37 2µ2/250V
R55 2k2
D22
D26
D27
3x5V6 400mW
R65 1k
IC11
6N139
R56 560k
C38 100n
R57 82k
IC16
R60 100k
C41 47/16
C43 1n
IC12
74LS221
R58 100k
R59 100k
C40 100/6·3V
C39 220/16

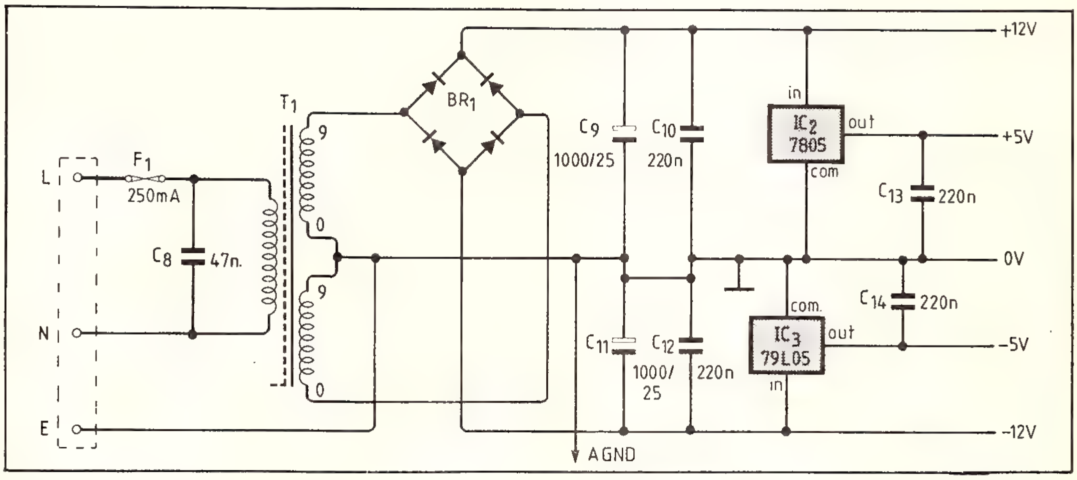
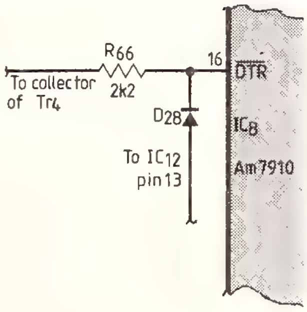
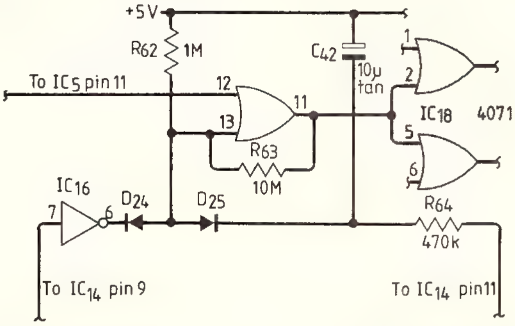


Fig.2. Space for this power supply is provided on the p.c.b.

Fig.3. Disabling RTS and DTR during the auto-answer sequence. This addition has been incorporated in the p.c.b. for this project.





phone handset at the same time. With some of the bulletin board systems listed in the box, it may then be necessary to type a few carriage returns to start things off.

At the end of the call, S$_3$ should be moved back to the centre position to break the connection. In the Viewdata mode, disconnection occurs automatically when the Prestel computer drops its carrier. This may happen prematurely if the RTS signal is removed: as this may occur momentarily while files are being saved to cassette or disc, it may be best to fix RTS permanently on in the modem. This can be done by linking pins 13 and 14 of IC$_5$; it may then be wise to cut the track between pin 13 and the 25-way socket to avoid contention when the full RS232 interface is used.

The third position of S$_3$ allows the modem to auto-answer calls from other computers. This facility is allowed only in the 300 baud 'answer' modes and in V.23 mode with S$_2$ set to 'reverse'.

Acquisition of a carrier in the back channel is indicated by LED$_1$, and in the main channel by LED$_2$. LED$_3$ lights when the circuit is powered and flickers during transmission of outgoing data. When a call is auto-answered, LED$_4$ lights; and LED$_5$ comes on when the modem is holding a line.

To test the modem off-line, set S$_2$ to the test position. The modem should then echo characters typed at the keyboard back to the screen. Note that this test may not work in the V.23 mode, since the Viewdata terminal software will set the RS232 driver and receiver to different data rates.

Some databases to try

The following 'bulletin board' systems are run by private individuals on a voluntary basis. No charges are made for use of their facilities, which include message handling, software downloading and news. Forum-80 systems use a seven-bit word with even parity and one stop bit; others have an eight-bit word with one stop bit and no parity bit.

Beware of 1200/75 systems: some use the same data format as on their 300 baud modems, and may not be compatible with Prestel terminal software.

CBBS Chiltern: 07073-28723, 07073-39241, 18.30-22.30h, Monday and Wednesday.
CBBS Cumbria: 069-92314*, 1800-2200h daily. V.21, Bell 103 and 1200/75 baud V.23.
CBBS Southwest: 0626-890014, 24 hours, V.21 and 1200/75 baud V.23.
CBBS Surrey (Woking): 04862-25174, 24 hours.
MG-NET CBBS (London): 01-399 2136, Sunday only, 17.00-22.00h.
CABB, *Computer Answers* bulletin board (London): 01-631 3076, 24 hours. Also weekdays on 1200/75 baud V.23.
Forum-80 (Hull): 0482-859169. Tuesday and Thursday, 19.00-22.00h; Saturday and Sunday, 13.00-22.00h. Night-time service for U.S.A. using Bell 103 tones, 00.00-08.00h.
Forum-80 (London): 01-902 2546, evenings and weekends.
Mailbox-80 (Liverpool): 051-428 8924, 24 hours.
Mailbox-83 (West Midlands): 0384-635336*, 17.30-08.30h daily and all day Sunday.
Manchester BB: 061-427 3711, Sunday-Thursday 22.30-00.0h, Friday 13.30-02.00h, Saturday 22.30-02.00h.
Microweb (Stockport): 061-456 4157, 24 hours. For users of the BBC Micro.
TBBS City (London): 01-606 4194, 24 hours. 1200/75 on Wednesdays.
TBBS London: 01-348 9400, 09.00-01.00h with CCITT V.21 tones, 01.00-09.00h with Bell 103 tones.
TBBS Southampton: 0703-437200, 17.00-08.00h weekdays, all day at weekends.
North Birmingham BBS: 0827 288810*, 24 hours.
Blandford Board: 0258-54494, 24 hours.
Stoke ITEC BB: 0728-265078, 24 hours.
Southern Bulletin Board: 0243-511077, 24 hours.
BASUG (British Apple Systems User Group board): 0742-667983, 24 hours.

The following commercial systems, operated by electronic component suppliers make no charge to users except where shown:

Distel (Display Electronics Ltd, London SE19): 01-679 1888 (V.21). A 1200/75 baud service is to be added: test port on 01-679 6183.
Estelle (STC Electronic Services, Harlow, Essex): 0279-443511 (V.21), 0279-442288 (V.23), business hours.
Rewtel (Cirkit, formerly Ambit International, Brentwood, Essex): 0277-232628. Some facilities are available only to subscribers.
Maptel (Maplin Electronics Ltd, Southend-on-Sea): 0702-552941.

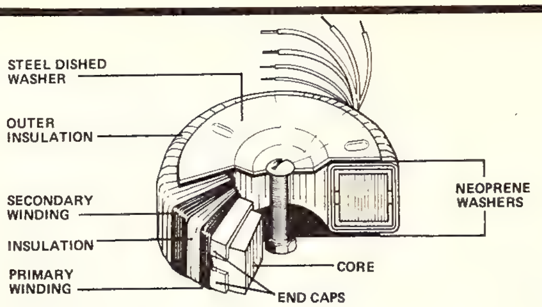
Viewdata

Prestel Microcomputing: details from Micronet 800, Scriptor Court, 155 Farringdon Road, London EC1R 3AD. Enquiries, 01-278 3143. The quarterly subscription of £13 (for domestic users) gives access to Micronet 800, Viewfax 258 and all sections of Prestel not restricted to other closed user groups.
Prestel: for information ask the operator for Freefone 2296.
*'Ring back' systems: dial the number, let it ring once, replace the handset and then dial again.

Addresses

Barrie Electronics Ltd, Unit 211, Stratford Workshops, Burford Road, London E15 2SP; 01-555 0228.
Combe Martin Electronics, King Street, Combe Martin, Devon EX34 0AD.
Computer Concepts, 16 Wayside, Chipperfield, Hertfordshire WD4 9JJ; 09277-69727.
Electrovalue Ltd, 28 St Jude's Road, Englefield Green, Egham, Surrey TW20 0HB; 0784-33603.
Maplin Electronic Supplies Ltd, P.O. Box 3, Rayleigh, Essex SS6 8LR; 0702-554155.
Molimerx Ltd, 1 Buckhurst Road, Town Hall Square, Bexhill-on-Sea, East Sussex; 0424-220391.
Pace Software Supplies Ltd, 92 New Cross Street, Bardford BD5 8BS; 0274-729306.
Technomatic Ltd, 17 Burnley Road, London NW10 1ED; 01-452 1500.

TOROIDALS



The toroidal transformer is now accepted as the standard in industry, overtaking the obsolete laminated type. Industry has been quick to recognise the advantages toroidals offer in size, weight, lower radiated field and, thanks to I.L.P., PRICE.

Our large standard range is complemented by our SPECIAL DESIGN section which can offer a prototype service within 14 DAYS together with a short lead time on quantity orders which can be programmed to your requirements with no price penalty.

15 VA
62 x 34mm 0.35Kg
Regulation 19%

SERIES No	SECONDARY Volts	RMS Current
0x010	6+6	1 25
0x011	9+9	0 83
0x012	12+12	0 63
0x013	15+15	0 50
0x014	18+18	0 42
0x015	22+22	0 34
0x016	25+25	0.30
0x017	30+30	0 25

(encased in ABS plastic)

30 VA
70 x 30mm 0.45Kg
Regulation 18%

1x010	6+6	2 50
1x011	9+9	1 66
1x012	12+12	1 25
1x013	15+15	1 00
1x014	18+18	0 83
1x015	22+22	0 68
1x016	25+25	0 60
1x017	30+30	0 50

50 VA
80 x 35mm 0.9Kg
Regulation 13%

2x010	6+6	4 16
2x011	9+9	2 77
2x012	12+12	2 08
2x013	15+15	1 66
2x014	18+18	1 38
2x015	22+22	1 13
2x016	25+25	1 00
2x017	30+30	0 83
2x028	110	0 45
2x029	220	0 22
2x030	240	0 20

80 VA
90 x 30mm 1Kg
Regulation 12%

3x010	6+6	6 64
3x011	9+9	4 44
3x012	12+12	3 33
3x013	15+15	2 66
3x014	18+18	2 22
3x015	22+22	1 81
3x016	25+25	1 60
3x017	30+30	1 33
3x028	110	0 72
3x029	220	0 36
3x030	240	0 33

120 VA
90 x 40mm 1.2Kg
Regulation 11%

4x010	6+6	10 00
4x011	9+9	6 66
4x012	12+12	5 00
4x013	15+15	4 00
4x014	18+18	3 33
4x015	22+22	2 72
4x016	25+25	2 40
4x017	30+30	2 00
4x018	35+35	1 71
4x028	110	1 09
4x029	220	0 54
4x030	240	0 50

160 VA
110 x 40mm 1.8Kg
Regulation 8%

5x011	9+9	8 89
5x012	12+12	6 66
5x013	15+15	5 33
5x014	18+18	4 44
5x015	22+22	3 63
5x016	25+25	3 20
5x017	30+30	2 66
5x018	35+35	2 28
5x026	40+40	2 00
5x028	110	1 45
5x029	220	0 72
5x030	240	0 66

225 VA
110 x 45mm 2.2Kg
Regulation 7%

6x012	12+12	9 38
6x013	15+15	7 50
6x014	18+18	6 25
6x015	22+22	5 11
6x016	25+25	4 50
6x017	30+30	3 75
6x018	35+35	3 21
6x026	40+40	2 81
6x025	45+45	2 50
6x033	50+50	2 25
6x028	110	2 04
6x029	220	1 02
6x030	240	0 93

300 VA
110 x 50mm 2.6Kg
Regulation 6%

7x013	15+15	10 00
7x014	18+18	8 33
7x015	22+22	6 82
7x016	25+25	6 00
7x017	30+30	5 00
7x018	35+35	4 28
7x026	40+40	3 75
7x025	45+45	3 33
7x033	50+50	3 00
7x028	110	2 72
7x029	220	1 36
7x030	240	1 25

500 VA
140 x 60mm 4Kg
Regulation 4%

8x016	25+25	10 00
8x017	30+30	8 33
8x018	35+35	7 14
8x026	40+40	6 25
8x025	45+45	5 55
8x033	50+50	5 00
8x042	55+55	4 54
8x028	110	4 54
8x029	220	2 27
8x030	240	2 08

625 VA
140 x 75mm 5Kg
Regulation 4%

9x017	30+30	10 41
9x018	35+35	8 92
9x026	40+40	7 81
9x025	45+45	6 94
9x033	50+50	6 25
9x042	55+55	5 68
9x028	110	5 68
9x029	220	2 84
9x030	240	2 60

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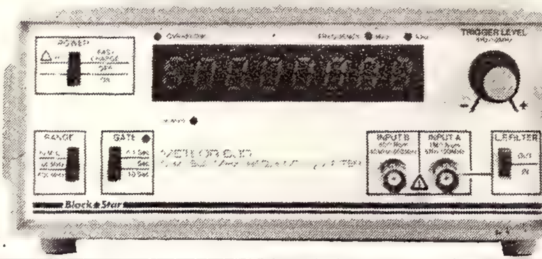

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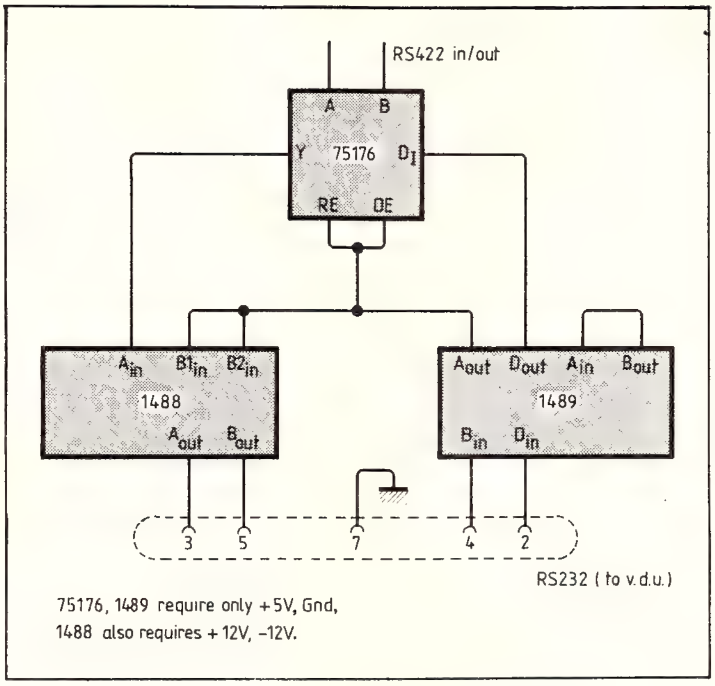
RS422/RS232 converter

RS422 is a half-duplex data-link standard and, being balanced, allows greater distances to be covered and higher data rates than are possible using RS232. It can also be used with one transmitter and several receivers ('multi-drop'). This circuit provides RS422 and line monitoring using an RS232 v.d.u. or computer.

Normally, the circuit is in receive mode and the v.d.u. monitors the line. When a key is pressed, line four on the RS232 nterface is inverted and the 75176 transmits the character. Receive mode is resumed on key release. Line five provides nformation on the direction of the line and may be omitted. Essentially, the circuit is a level converter and therefore ndependent of data rates. Note that direction reversal time on an RS422 line can be far shorter than that of a simple v.d.u., which can lead to apparent loss of characters. A twisted pair should be used for the 422 line as the 75176 is very sensitive, and care should be taken with layout.

L. Smith
Blackford
Perthshire



75176, 1489 require only +5V, Gnd,
1488 also requires +12V, −12V.

DON'T WASTE GOOD IDEAS
We prefer circuit ideas with neat drawings and widely-spaced typescripts, but we would rather have scribbles on "the back of an envelope" than let good ideas be wasted. Submissions are judged on originality or usefulness — not excluding imaginative modifications to existing circuits so these points should be brought to the fore, preferably in the first sentence. Minimum payment of £30 is made for published circuits, normally early in the month following publication.

Isolated video driver

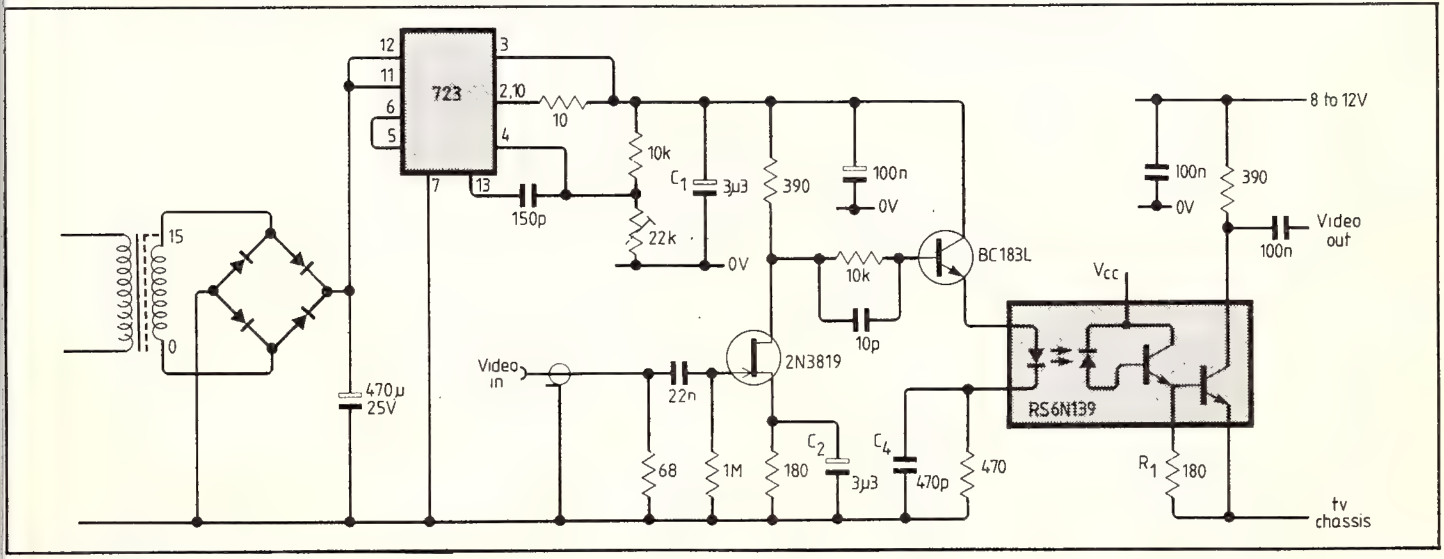
Designed for connecting computer video output to a non-isolated domestic tv, this circuit uses a readily available 6N139 optical coupler (RS Components) operating at 1:1 current-transfer ratio. Positive video modulation is assumed and, for the UK, a composite video-signal bandwidth requirement of 6MHz.

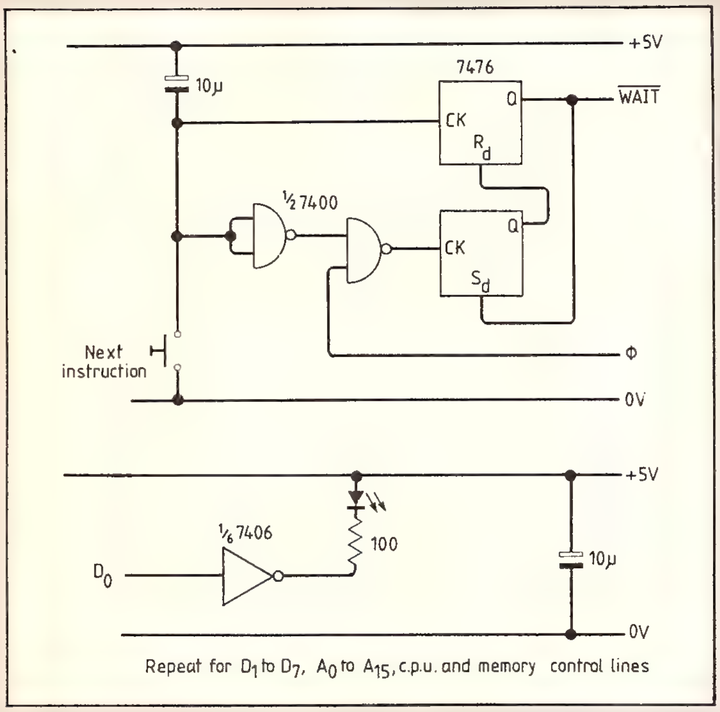
Voltage gain of the fet stage is about four. The source is directly coupled to the next stage which approximates a current drive for the coupler led. Bias current of around 9mA, determined by the fet drain/source resistors and supply voltage, keeps the optical-coupler transfer characteristic in its linear region. Capacitor C_3 negates the effect of Miller capacitance in the driver transistor and C_4 extends frequency response to above about 800kHz by quickly removing stored charge in the transistor emitter during voltage transitions. Resistor R_7 is set for optimum rise and fall times.

Collector current in the opto-coupler is about 7mA, allowing low resistor values to be used to shunt Miller capacitance so that the transistors can operate at maximum speed. Direct-current supply for this stage may come from the tv; in valve sets, the sound output-valve cathode might be used.

The prototype gave rise and fall times of 200ns corresponding to a bandwidth of 5MHz which should be sufficient for most home computers. Bandwidth is mainly limited by the opto-coupler and faster devices should work with only minor modifications since the driver bandwidth is about 20MHz. Layout is critical — all tv circuit tracks should be separated from the grounded side by at least 4mm for insulation, and signal paths should have minimum stray capacitance. Video signal from 75Ω coaxial cable is terminated and should be about 1V pk at the input and large values of $C_{1,2}$ are required for faithful reproduction of frame-sync. pulses. Output is about 4V pk and may need to be divided for some sets.

J. A. McLay
Ballincollig
Co. Cork
Ireland



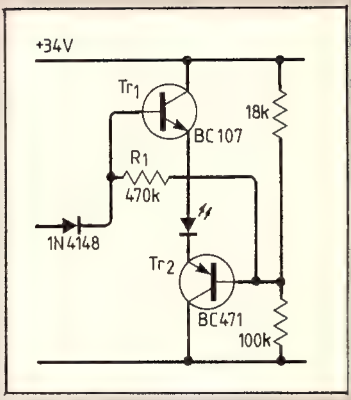

+5V
10μ
7476
Q
WAIT
CK
Rd
½7400
Q
CK
Sd
Φ
Next instruction
0V
+5V
⅙7406
100
D0
10μ
0V
Repeat for D1 to D7, A0 to A15, c.p.u. and memory control lines

Microprocessor teaching aid

Using the WAIT command, the Z80 microprocessor can be made to execute one instruction at a time under control of a manual switch. If all the address, data and control lines are monitored, the processor can be seen fetching/storing information and carrying out commands.

While the switch is open, WAIT is low. When the switch is closed, the upper bistable device is clocked and WAIT goes high. Simultaneously, pulses from the processor clock feed the lower bistable i.c. and after two rising edges, the output of the lower device goes low and resets the upper one. Thus WAIT returns low after one or two clock cycles and sets the lower bistable i.c. Note that dynamic memory content will be lost since the memory-refresh circuit cannot operate. The circuit has been used with a ZX81 (no ram expansion), connected through the 23-row connector to make internal soldering unnecessary. A binary-to-hexadecimal converter and display on the data lines is a useful addition.

Peter Hall
University College London


+34V
Tr1
18k
BC107
R1
470k
1N4148
Tr2
BC471
100k

Simple clipping detector

No setting up is required on this simple clipping detector for audio power amplifiers. When positive output swing exceeds

$$V_{b1}+V_{eb1}+V_{led}+V_{be2}+V_{D1}$$

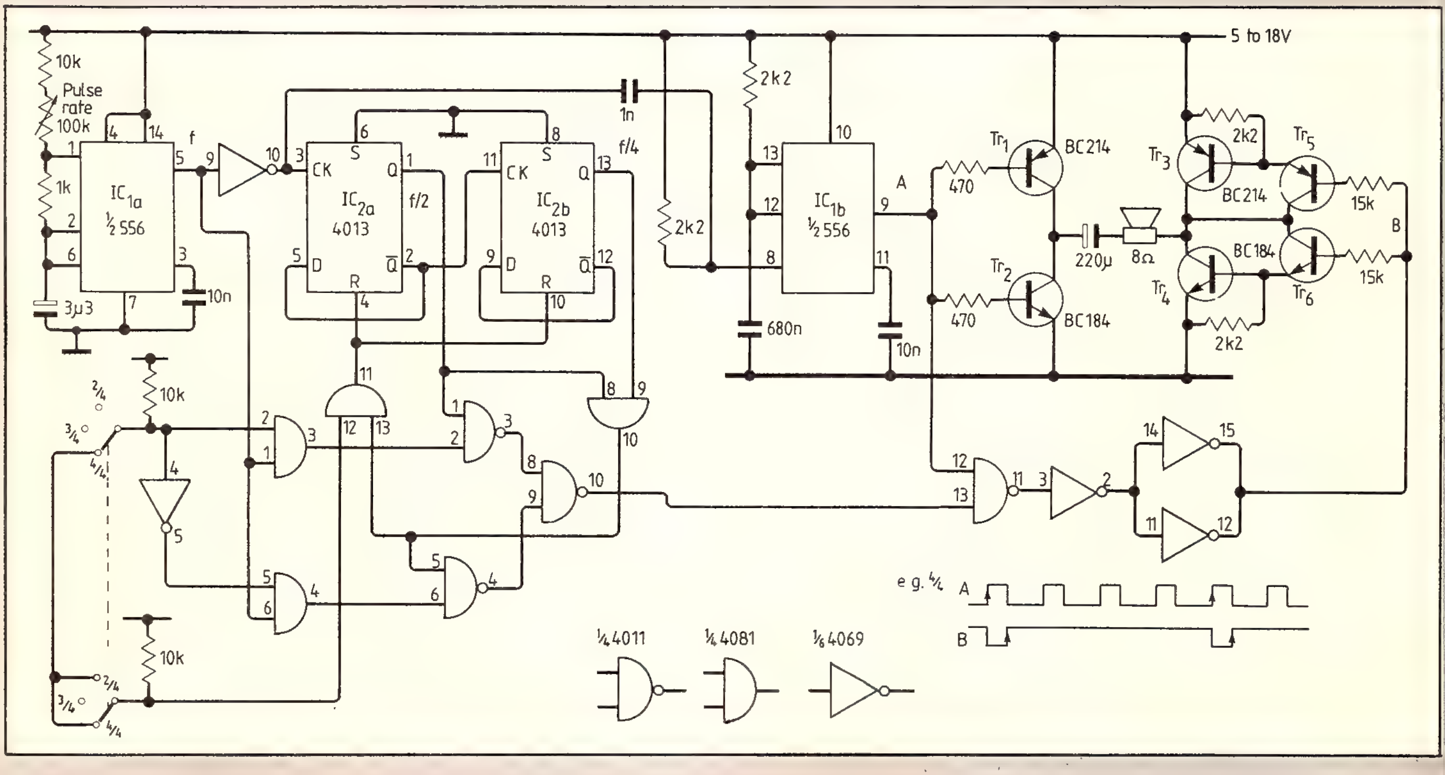
the led lights. Values shown are for a 34-0-34V supply and switch the led on at 64V pk-pk, but they may be altered to suit any single or dual-rail power amplifier. Tolerance on the switching point is about 0.5V due to junction effects. Resistor R_1 and the diode protect Tr_2 during negative swing.

M. J. Conduit
Farnham
Surrey

Accentuated metronome

Loud regular pips — clearly audible even above my attempts to master the guitar — are generated by this metronome. Each pulse from IC_{1a} triggers a fixed-duration pulse from IC_{1b} which drives the loudspeaker through $Tr_{1,2}$. Normally, common collectors of Tr_{3-6} are approximately at ground potential but counting and decoding circuits around IC_2 cause Tr_{3-6} to be driven in opposition to $Tr_{1,2}$ on the first beat of each bar to give an accentuated pip. Time signatures of 2/4, 3/4 or 4/4 are selected by a switch. Supplies of between 5 and 18V may be used. I used two PP3 batteries to give 18V in the prototype.

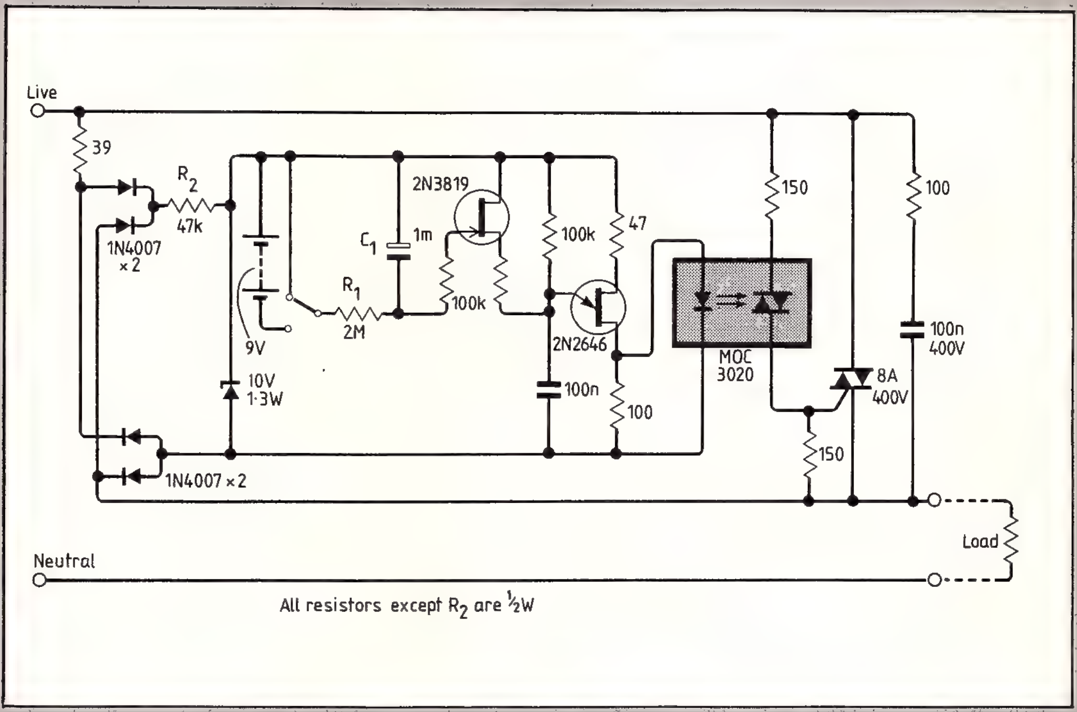
Steve Kirby
East Molesey
Surrey


5 to 18V
10k
Pulse rate
100k
1k
IC1a
½556
3μ3
10n
f
IC2a
4013
f/2
IC2b
4013
f/4
1n
2k2
2k2
IC1b
½556
680n
10n
A
Tr1
BC214
470
Tr2
BC184
470
220μ
8Ω
Tr3
BC214
2k2
Tr5
15k
B
Tr4
BC184
2k2
Tr6
15k
2/4
3/4
4/4
10k
10k
e.g. 4/4
A
B
¼4011
¼4081
⅙4069

Artificial daylight

For applications including tropical fish-tank lighting, this circuit gradually changes lamp brightness from off to full-on in 25 minutes, or vice versa depending on the switch position. A bridge rectifier and shunt zener diode provide mains synchronized d.c. pulses. Triac firing, through an opto-coupler, is from a unijunction transistor whose time constant is determined by a fet acting as a variable resistor. The capacitor which biases the fet, is charged or discharged depending on the switch position. If R_1 is disconnected, brightness remains constant for at least 24h through charge in C_1.

J. Clegg
Doncaster
Yorkshire

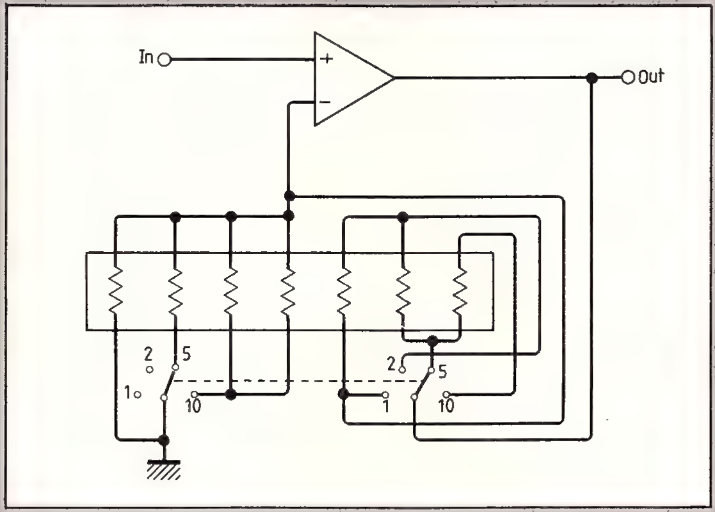


All resistors except R_2 are ½W

Accurate switched-gain for op-amps

Using a cheap array of seven equal resistors provides accurate switched op-amp gains of one, two, five and ten times. Resistance ratios for these gains in a non-inverting amplifier are 0^2, 1^2, 2^2 and 3^2 respectively so the input resistor may be made from zero, one, two or three resistors in parallel, and the feedback resistor form the same number of resistors in series.

B. P. Cowan
Bedford College
University of London

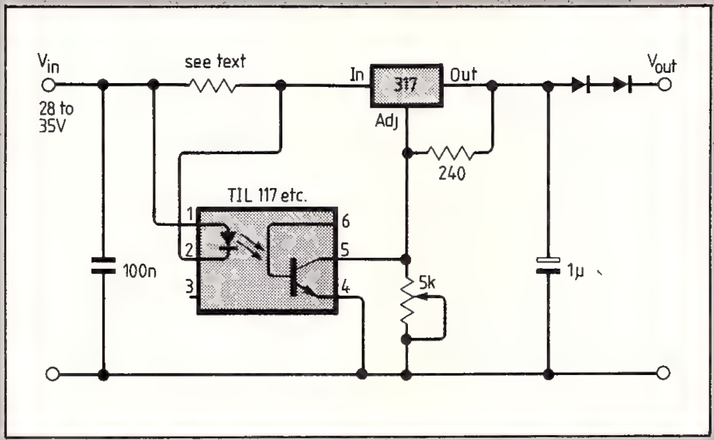


Current limiting for 317 regulators

Addition of an opto-isolator to a 317-based variable-voltage power supply allows precise current limiting. I have used this circuit to protect transistors during development of r.f. output stages of uncertain behaviour and t should be possible to apply this idea to simpler power supplies using power-transistor/zener-diode combinations.

When voltage across the series-pass resistor exceeds around 1V the isolator photodiode starts to emit, turning on the phototransistor and reducing control voltage to the regulator. Output diodes keep regulator output voltage at 1.5V above control voltage to limit output current under a dead short. Power and resistance ratings of the series resistor are chosen to suit the required current limit and the diodes must be able to carry more than the current limit value.

Lionel Sear
Truro
Cornwall



Combination lock with deterrent

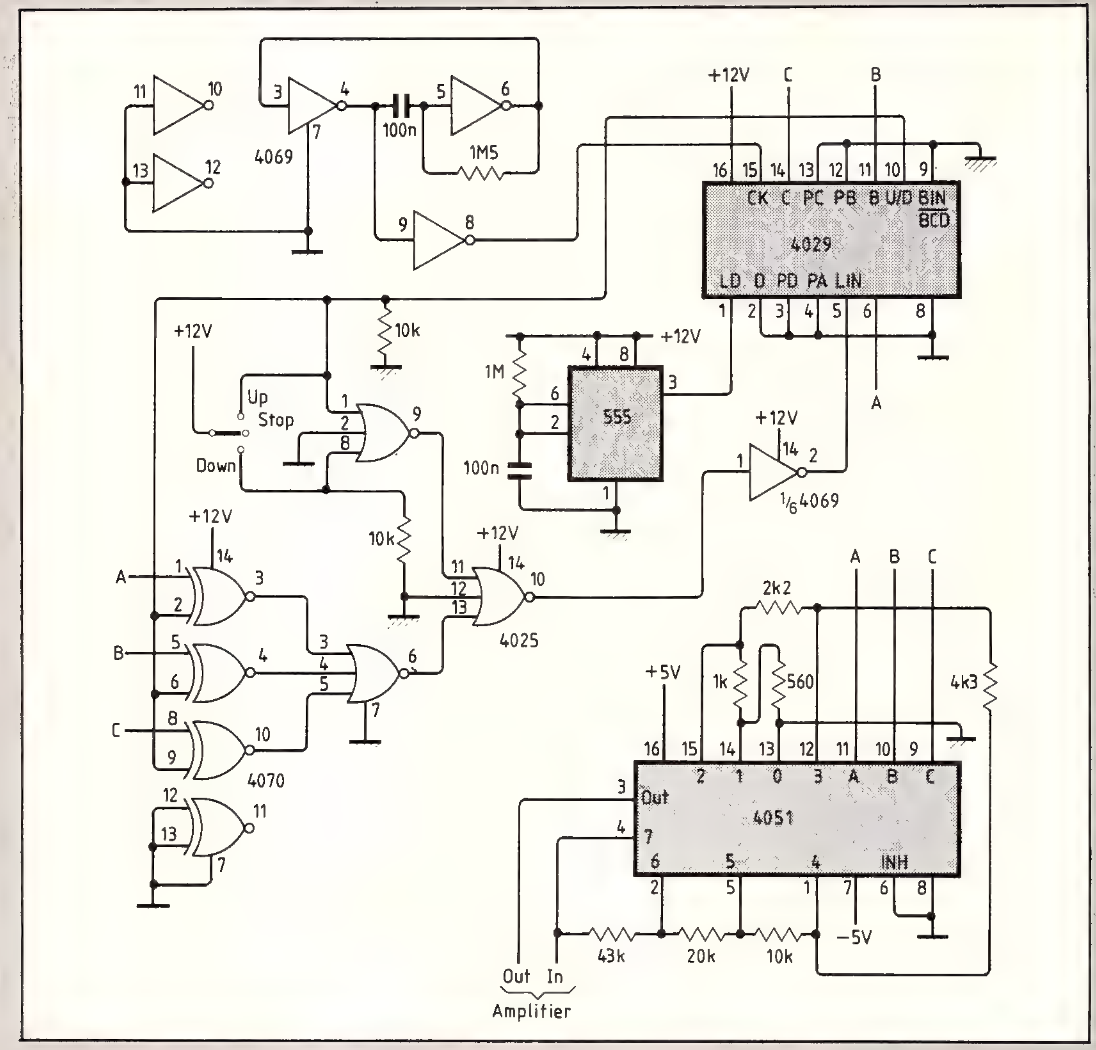
In this idea in the May issue, IC_1 should have been a 74148, E_O of IC_2 is not connected to E_I of IC_1, the transistor shown should have a base resistor and IC_{17a} is the left-hand section. On IC_6, Q and $\overline{Q}$ should be transposed. We apologise for these errors.

Remote volume control

Heart of this circuit, which requires only contact closures for volume increase/decrease, is a 4051 eight-channel multiplexer operating in analogue mode. The setting of this variable attenuator depends on output states of a 4029 up/down counter which is stepped through on contact closures under control of a buffered clock signal from pin eight of the 4069 inverter. Frequency of the clock is RC/2.2 and a 555 timer ensures that the volume level is low when the circuit is switched on.

One 4051 is required for each further audio channel, the maximum number of channels only being limited by 4029 drive capability.

Dennis J. Eichenberg
Ohio
USA



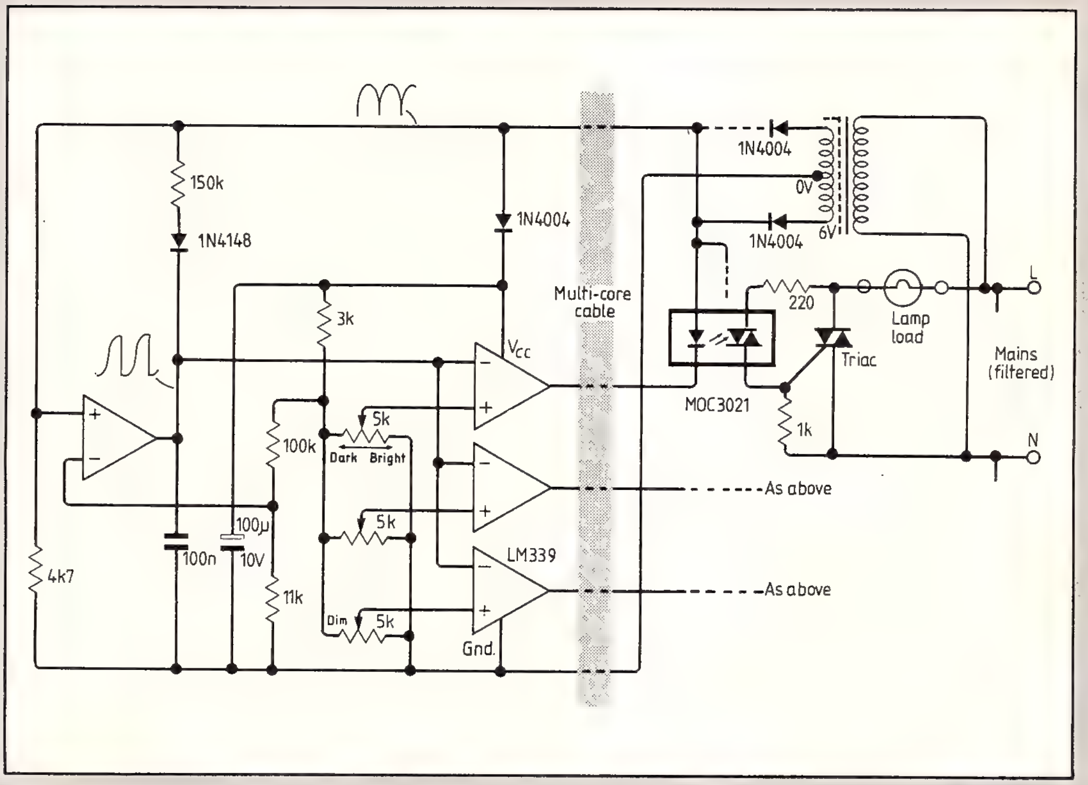
4069
100n
1M5
+12V
C
B
4029
CK C PC PB B U/D BIN/BCD
LD D PD PA LIN
10k
+12V
Up
Stop
Down
1M
555
100n
A
+12V
1/6 4069
10k
4025
A
B
C
4070
A B C
2k2
+5V
1k
560
4k3
4051
Out
INH
43k
20k
10k
−5V
Out In
Amplifier

Three-channel light dimmer

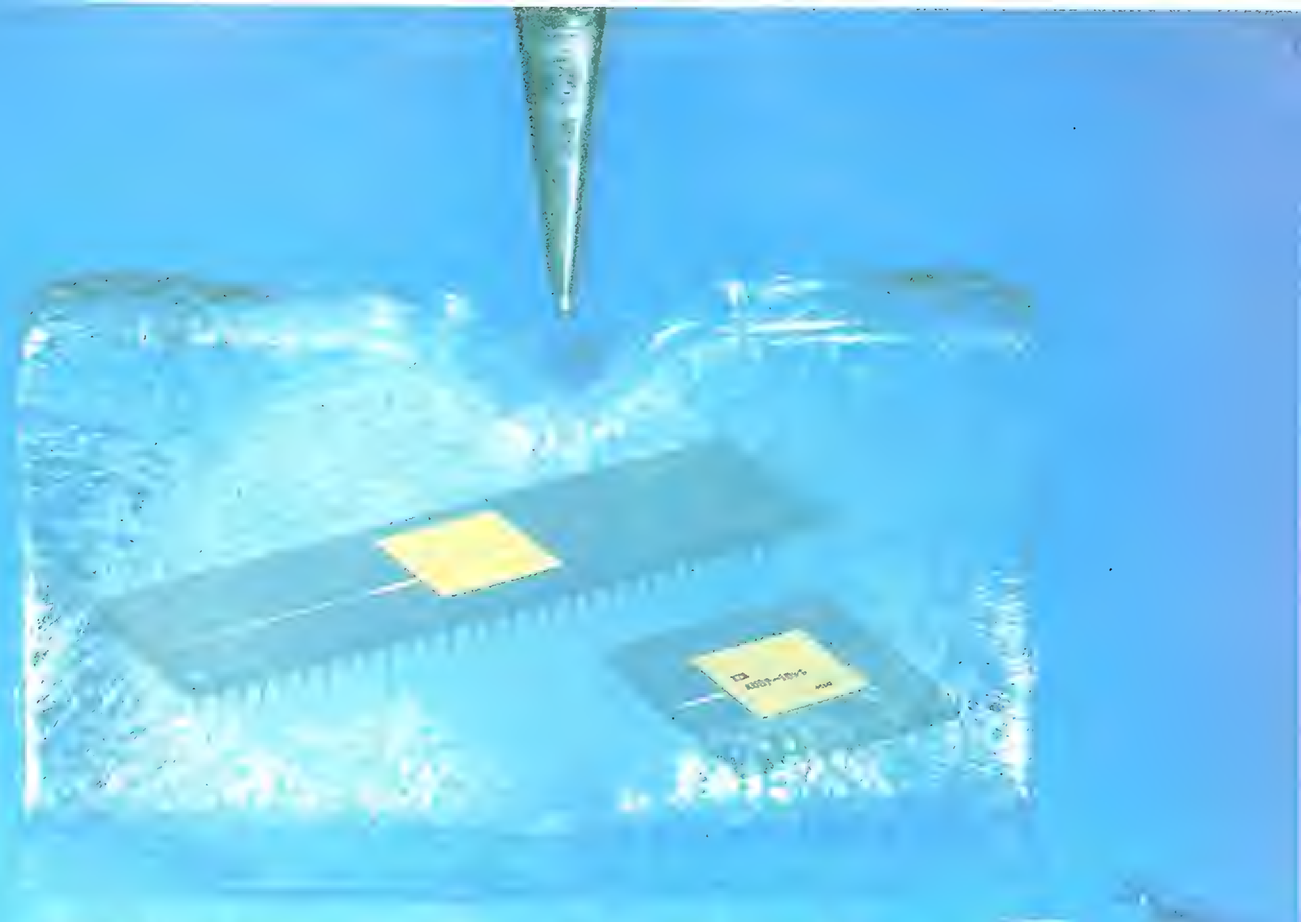
Using a non-linear ramp to linearize power output, this light dimmer with three channels requires few components and allows triacs to be fired remotely through non-mains carrying cable. Remote firing also means that the triacs can be mounted next to the load which simplifies mains filtering. Channels may be added by using further comparators, isolators and triacs.

Advantage is taken of the LM339 open-collector outputs to eliminate series resistors at the three phase-control sections and directly discharge the ramp capacitor. Transformer output should not exceed about 6V to prevent excessive dissipation in the LM339.

Tim Williams
Tunbridge Wells
Kent



150k
1N4148
1N4004
Multi-core cable
1N4004
0V
1N4004
6V
220
Lamp load
Triac
L
Mains (filtered)
N
MOC3021
1k
3k
Vcc
5k
Dark Bright
100k
5k
As above
100μ
10V
100n
4k7
11k
LM339
Dim
5k
Gnd.
As above



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ADSP 1008	8 x 8 MULT/ACC	TDC 1008J	0.1	105	120	140
ADSP 1081	8 x 8 UNSIGNED MULT.	MPY 8HUJ	0.1	75	90	105
ADSP 1012	12 x 12 MULTIPLIER	MPY 12HJ	0.15	110	130	150
ADSP 1009	12 x 12 MULT/ACC	TDC1009J	0.15	130	155	180
ADSP 1016	16 x 16 MULTIPLIER	MPY 16HJ	0.15	145	170	200
ADSP 1010	16 x 16 MULT/ACC	TDC 1010J	0.15	165	190	220
ADSP 1110	16 x 16 SINGLE PORT MAC	PROPRIETARY	0.15	165	190	220
ADSP 1024	24 x 24 MULTIPLIER	PROPRIETARY	0.25	200	235	275

*Contemporary ECL and Bipolar parts are spec'd for a maximum CASE temperature of 125°C. Due to their high dissipation this corresponds to an ambient of about 95°C. Analog Devices Military CMOS parts are spec'd at an AMBIENT of 125°C.

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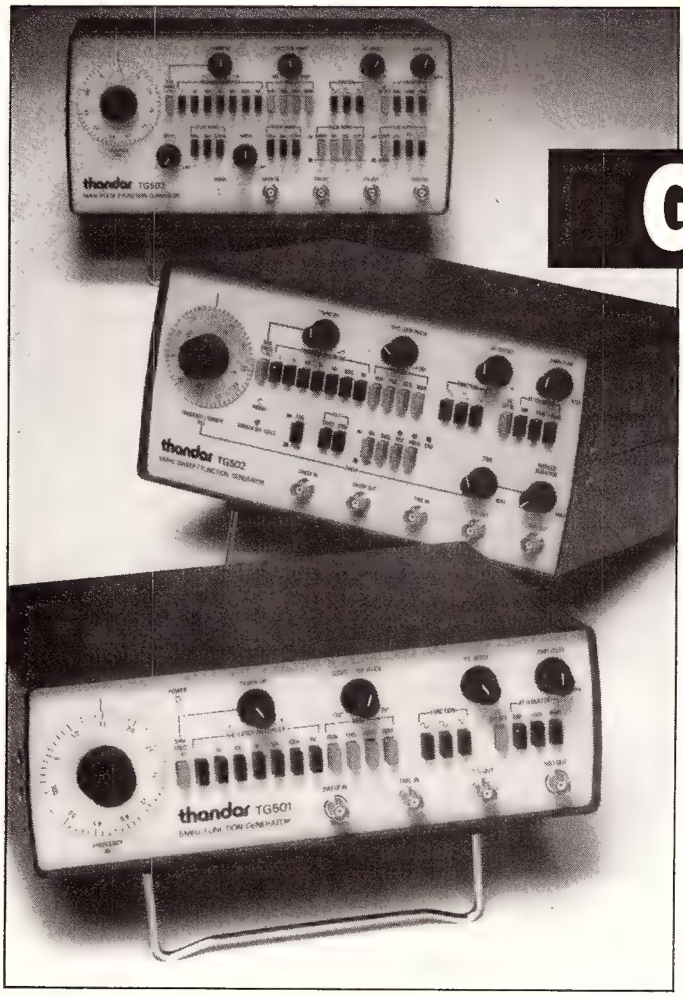

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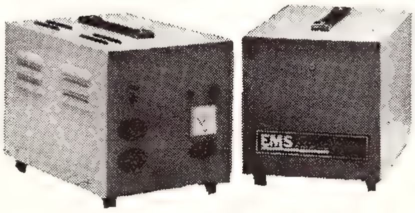
ELECTRONICS LIMITED

CIRCLE 21 FOR FURTHER DETAILS.

E.M.S. POWER SYSTEMS



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CIRCLE 32 FOR FURTHER DETAILS.

Fibre optics communications

by Brett Wilson

Part 3 — Systems and applications.

This last article in this three-part series looks at the range of applications in which fibre optic systems are being introduced.

In view of the very low energy levels involved in fibre optic transmission they are best suited to the transfer of information rather than power. It is in this area that they are making a major impact, even at this relatively early stage of their development. Indeed, British Telecom has recently announced that it will be ordering no more coaxial cable after 1985 for the telephone network, due to their growing commitment to fibre optics. It has been predicted that over half of all trunk telephone traffic will be carried on optical fibres by 1991.

There is no difficulty in principle in substituting optical fibres for copper cables in the majority of data transmission applications. After multiplexing the data in the normal manner the electronic modulator drives a light emitting or laser diode rather than a coaxial line amplifier, Fig.1. At the receiving end the signal can be treated again in the conventional manner once it is beyond the detector preamplifier. In small systems the additional complexity is minimal, whilst complex data systems such as telephone trunk routes can actually be simplified by adopting optical fibres as the transmission medium.

The range of telecommunications applications for fibre optics can be conveniently divided into three areas

- —public telephone network
- —broadband entertainment and information services
- —computer local area networks.

Public telephone network

Because of the very low bandwidth required for each telephone handset, it is doubtful if there will ever be an economic need to replace the usual copper wire pairs with an optical fibre. (This position changes of course when considering an integrated data network including telephony, television and data link). The major fibre application is in the area of junction and trunk telephone transmission where the traffic has been concentrated and multiplexed to a much higher data rate. Here experience has shown that the first generation systems have fallen into several broad performance areas, as we would expect from the previous look at fibres, sources and detectors.

The majority of installations have operated at a wavelength of around 0.85μm using medium performance graded index fibre with silicon avalanche photodetector receivers, Fig.2. Where the main consideration was not maximum repeater spacing l.e.ds have normally been used because of their lower cost, resulting in repeater separations of around 6km in the 30-45Mbit/s and 7km in the 100-140Mbit/s range[1]. The latest phase of the first generation systems has seen the use of the dispersion null at 1.3μm with low attenuation fibres resulting in even greater spacings for medium data rates.

An additional advantage arising from the increased repeater spacings is that well over 50% of the connections between major switching centres within cities can now be made repeaterless, with an increase in reliability and decrease in cost. This has also been the pattern of experience in N. America, Europe and Japan.

Optical fibres are not usually laid as a single fibre. Instead a number of them, eight being common, are made up into a cable around a steel strength member.

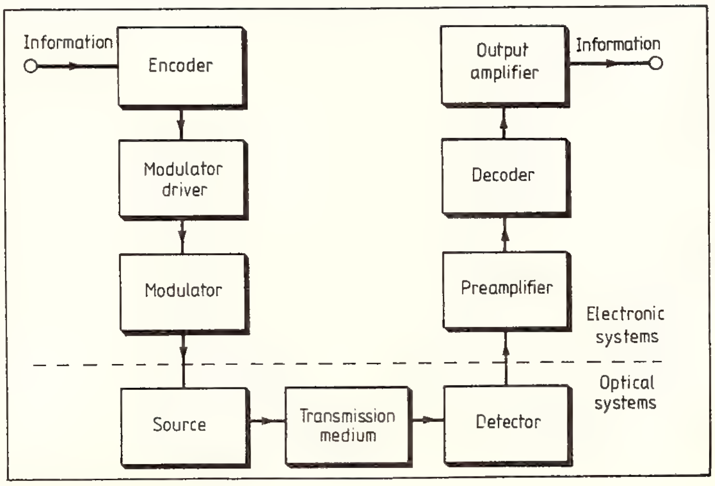
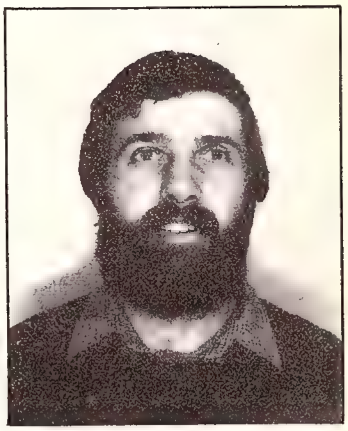


Fig.1. **Principal components of an optical communications system.**



After a post doctoral fellowship at Manchester University, and a year teaching in Baghdad, Brett Wilson returned to Manchester to work on optical position detectors and sensitive non-contact current measurement. He then lectured at Nottingham University, where he's been concerned with novel uses of op-amps in addition to fibre optics, and is now back in Manchester, this time at UMIST. His Ph.D. was on a high-speed laser stroboscope for magnetic bubble research.

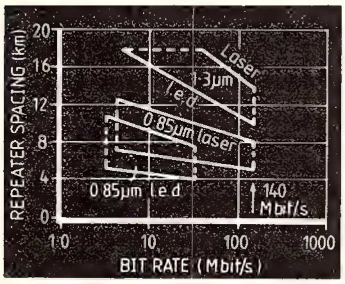
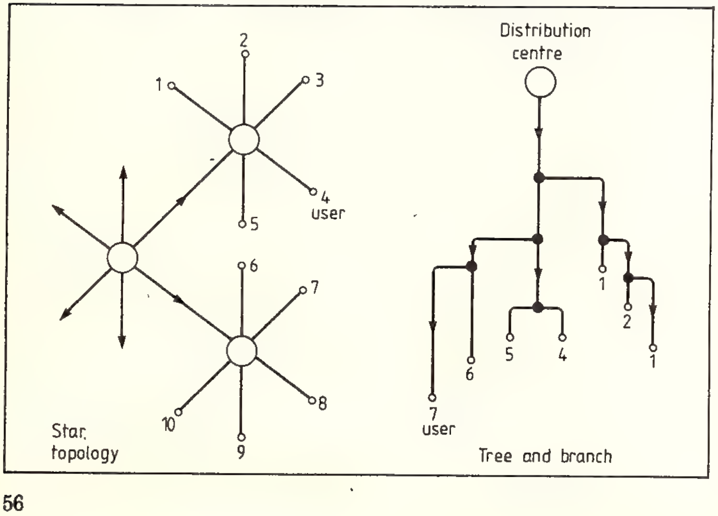


Fig.2. **Longer wavelength laser systems offer the best combination of repeater spacing and data rate, but shorter wavelength l.e.d. systems are less costly.**

Fig.3. **Tree and branch topology is best suited to broadband broadcast distribution in contrast to the star configuration which permits much easier installation of up-stream selection signalling.**



Most of the cables are installed in existing ducts where their small size is a great advantage in an already crowded environment. Lengths of around 1km of optical cable are usually pulled through the ducts before being jointed using V-groove or arc-fusion techniques.

For second generation systems effort is being concentrated on long-haul high-speed communications where the cost is affected strongly by repeater spacings. Hence it is natural to use laser driven monomode fibres in their minimum dispersion region at 1.3µm. Repeater spacings of 20km are typical with data rates of 400Mbit/s being employed (NTT, Japan) over routes ultimately several thousand kilometres in length[2]. Most field trials, however, have been conducted with shorter routes of around 100km.

The promise of low-loss transmission with high data rates is obviously of great importance in the area of underwater telephone cables. In addition, the lower weight and smaller size of optical fibres compared to copper coaxial cables is of great economic and handling importance considering the long lengths of cabling, approximately 6500km, involved in a transatlantic crossing. The various agencies concerned have mapped out the nature of the first optical fibre transatlantic telephone cable, TAT 8, to be installed in 1988.

It is intended to operate multiple optical fibre pairs at 280Mbit/s, equivalent to 35,000 two-way voice channels, with repeater spacings of more than 35km. Monomode fibre will be used excited by 1.3µm injection laser diodes. Strength is provided by the usual arrangement of central and peripheral steel elements with cushioning from interstatial elastomer and an external polyethylene coating. Water resistance and electrical power in the form of a constant current for the repeater electronics is obtained via a continuously welded copper cylinder jacket. The overall diameter of the completed cable will be just over 20mm; under half the diameter of the previous copper coaxial TAT 7 cable.

The underwater repeaters, which have not yet been finalised, will probably use up to four laser transmitters, one actively employed and the other three as standby units. This is thought to be necessary because of the limited lifetimes so far achieved with i.l.ds coupled with the enormous cost of underwater repairs. Optical detection is performed by an InGaAs p-i-n diode rather than an a.p.d. because of the complexity of providing a high voltage supply to an a.p.d. A silicon bipolar transimpedance preamplifier is used in preference to a GaAs unit because as yet silicon fabrication technology is more proven than that required for GaAs. Active waveform retiming is carried out at each repeater by clock extraction circuitry. Various monitoring circuits transmit operational information back to the shore based stations.

Broadband information services

The use of optical fibre technology has been much discussed with respect to the 're-cabling of Britain', where a single unit on the customer's premises would provide access to a wide range of tv channels and interactive information service. Connections between the customer's unit and the distribution centre can obviously be of the ordinary copper coaxial cable type or by optical fibres, either of which could be arranged as a tree and branch, or switched star topology, both of which are shown in Fig.3. The switched star system is currently favoured as offering the greatest future potential for system expansion. In contrast, over 80% of all American coaxial cable systems use a tree and branch topology.

Owing to the inherent difficulties and signal losses involved in splitting the signal in an optical fibre, it is likely that its use in a tree and branch network would be restricted to the main trunk. In a switched star network, however, the signal paths are a series of point to point transmissions ideally suited to the characteristics of optical fibre technology.

Most of the field trials that have been conducted around the world (UK, USA, Canada, Germany and Japan) to assess the potential of fibre optic transmission links have relied on some form of analogue intensity modulation of the light source. The reason is simply that frequency division multiplexing onto ever higher frequency carriers has been the traditional manner in which to multiplex telephone, and by extension, television channels. Analogue intensity modulation performs satisfactorily with coaxial cable techniques but does not ideally suit optical sources since in general they are non-linear unless pre-biasing techniques are employed. Even then circuit complexities arise because the lasing threshold of a semiconductor injection laser is temperature sensitive. The best properties of the optical transmission systems discussed in the previous articles are brought out by binary intensity modulation, i.e. on or off. For a fully integrated data network this is obviously the best form of modulation as it renders unnecessary any form of modulation change between the computing section and the distribution section.

However, there are certain bandwidth penalties to be paid when attempting to encode tv channels in a completely digital format. in an analogue format a PAL colour signal will occupy a bandwidth of 6MHz, but with eight-bit p.c.m. digital encoding this increases dramatically to around 120MHz to satisfy sampling requirements at an appropriate multiple of the colour subcarrier. In other words a single digital tv channel would occupy the equivalent of a 140MHz optical fibre telephone trunk circuit! Even with bandwidth compression techniques this figure is only reduced to approximately 70MHz. Clearly there is a problem in providing every user in a tree and branch network with an optical fibre and receiver electronics with sufficient bandwidth at an affordable price, capable of bringing in perhaps 10 or 20 simultaneous tv channels and ancillary services.

A switched star network overcomes many of these problems by employing upstream low speed signalling, so that customers may indicate to the star switching centre which service or channel they want at any given time. The switching centre then routes the required signal down the customer's line, which obviously only need sufficient bandwidth for one service at a time. The primary routes from the main control centre to each of the switched star centres must of course be able to carry the full range of services simultaneously.

British Telecom has gained valuable experience in this field with their Milton Keynes 'Fibrevision' experiment in which 18 houses received a full range of services via optical fibres[3]. Based on this experience, BT are proposing a 'Multi-star Wideband Network' offering

—broadcast tv, d.b.s. tv, subscription tv, pay per view
—videotex; alphanumeric and photographic
—individual video, e.g. library discs
—home data services.

The proposed topology of the network is shown in Fig.4. The originating site, or super head-end, would house the data library as well as the off-air tv and video equipment. This site would be connected by optical fibre 'super primary links' up to approximately 20km in length with no repeaters, to a number of hub sites. Each of these hub sites would simply regenerate and distribute the information over 'primary links' to a maximum of 120 wideband switching points where the real intelligence and flexibility of the system resides. The full range of services is available to all the switching points, but programmes are only transmitted down the 'secondary links' to each customer when they demand a specific tv channel or service.

It is envisaged that each wideband switching point will be able to service up to 300 customers with cable runs up to 500m. Even though the Fibrevision trial used optical fibres for these secondary links it is considered that cost still favours small bore coaxial cables, at least for the next few years. Eventually the secondary links will also be optical fibres. Each customer will be able to receive two simultaneous tv channels and a range of f.m. stereo sound encoded by frequency division multiplex on their 120MHz bandwidth secondary link. A customer termination unit, a small set-top u.h.f. converter and a remote control handset completes the information/control chain.

Where a super primary link to the super head end is relatively short it is intended to utilise 50μm graded index fibre driven by a 0.85μm semiconductor laser. On the longer super primary links it may be necessary to use 1.3μm monomode fibre. Each link will be composed of ten fibres. There will be five fibres for a full range of off-air and subscription television, with each fibre carrying four frequency multiplexed frequency modulated tv channels, resulting in a total of 20 broadcast channels.

Of the remaining five optical fibres constituting the 10 fibre link, three will be for dedicated tv bandwidth channels such as on-demand video library and videotex, again multiplexed four per fibre. Each fibre will be optically modulated by analogue intensity modulation. The remaining two fibres will carry switching and control signals — one upstream and one downstream.

At a hub site the optical signals are simply regenerated and relayed out to the wideband switching points. A firm decision does not seem to have been taken whether to use an injection laser diode along with an avalanche photo detector at 0.85μm on a graded index fibre for the primary links, or whether to upgrade an i.l.d. or l.e.d. at 1.3μm with a p-i-n fet receiver, again using graded-index fibre. What is certain is that in the primary links the five fibres containing the 20 broadcast tv channels will be optically tapped to serve several switching points. The primary links between hub sites and switching points will be less than 5km in length.

Within each wideband switching point a microprocessor-controlled matrix type of routing switch will route the 20 broadcast tv channels as demanded by each of up to 300 customers. Each customer will be able to receive two channels simultaneously. Requests for individual video programmes in the form of discs will be relayed up through the system to the super head end, which will then replay on one of the dedicated channels back down through the hub site and the customer's own switching point and out on to the customer's own secondary link.

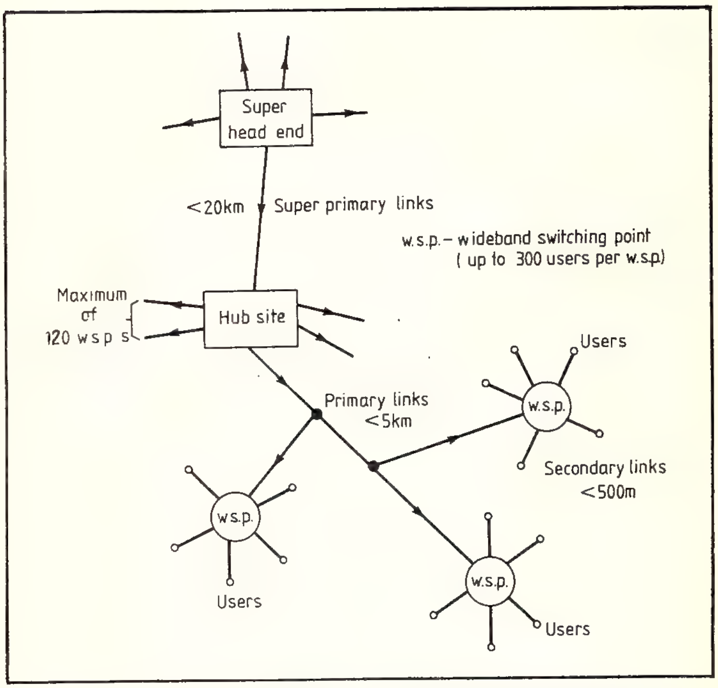


Fig.4. **British Telecom's proposed multi-star wideband network will use fibre optics in all but the short final link to the customer.**

Local area networks

A lan is a communications network connecting a number of users within a local geographical area to shared computing resources. The two most common topologies have been the contended bus with collision detection (Ethernet) and the ring structure, as in the Cambridge ring, Fig.5. Many of the features of optical fibres make them attractive for use in lans but usually only after some modification from a coaxial cable design has been implemented.

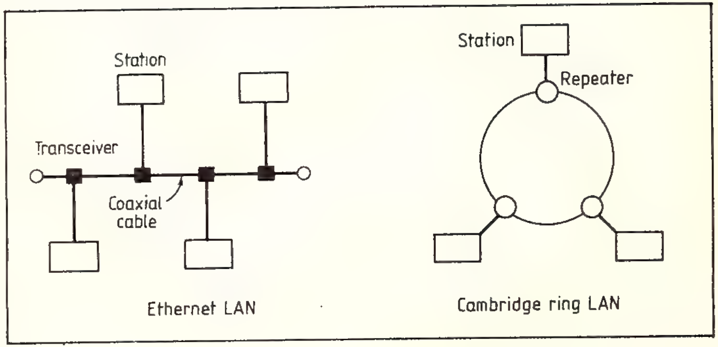


Fig.5. **Ethernet-style local area network uses a bi-directional data highway approach compared to the enclosed path of a Cambridge ring lan.**

In the Ethernet system each station is connected to the coaxial bus via a bidirectional passive tap, making insertion of a new work station a relatively simple matter. Each station attempts to transmit its message when the bus is quiet. If a message collision is detected transmission is stopped and retried a short time later. With fibre optic technology it is relatively difficult to make passive couplers without an unnacceptably high loss, thus restricting severely the number of users that may be attached to the bus. To overcome this, Fibernet, the optical version of Ethernet, uses a central passive star coupler to enable 16 users to com-

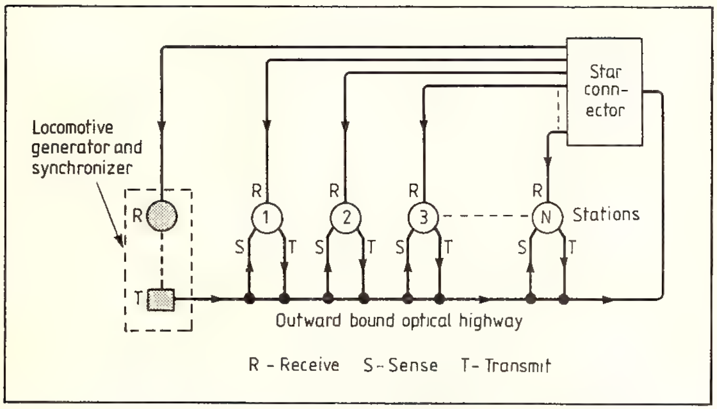

Star conn-ector
Locomotive generator and synchronizer
R
T
R
1
S
T
R
2
S
T
R
3
S
T
R
N
S
T
Stations
Outward bound optical highway
R - Receive S - Sense T - Transmit

Fig.6. D-Net optical lan combines a data highway and a star return, making it more like an open ring.

municate with each other.

At higher data rates, such as can be supported on fibre optics, the efficiency of a message contention scheme starts to fall rapidly. The transmission delay is not deterministic and the network cannot guarantee to support real time transmission such as telephony.

The alternative is a ring network. This structure suits the nature of fibre optics better because it is essentially a series of point to point transmissions. Since the signal is regenerated at each station there is little trouble with power levels. To increase the reliability of communications with respect to fibre failure for example, a double ring may be easily employed.

While commercial versions of optical ring lans are available, development attention is focusing more on structures such as D-Net where high data rates and low delays are obtainable[4]. Fig.6 shows an outline of D-Net in its star coupled form with a single star connector at the far end of the outward bound bus. The transmitter T sends regular 'locomotive' header signals out along the highway which are detected by all stations at their S-terminal. At each station a message packet may be attached to the appropriately numbered 'wagon' slot after the locomotive has passed. Because the locomotive is a synchronized event, re-triggered by reception of a previous locomotive back at the terminus R, the message delay through the system is tightly bound.

At the far end of the highway, the star coupler distributes the trains of information back to the receive terminals of all the stations. Just as there can be more than one train on the line between Manchester and London, so will D-Net support more than one train at a time, given a detailed knowledge of the maximum propagation time, bit slot lengths and number of stations. This configuration seems extremely attractive at very high speeds beyond 100Mbit/s because it retains a higher efficiency than a passive bus arrangement.

Fibre-optic sensors

One of the aims of research workers in the field of fibre optics has been to stabilize the transmission of information along an optical fibre against commonly encountered environmental changes, for example; pressure, temperature, strain, etc. they have succeeded to an extent where, in many applications, fibre optics is, or will soon be, the preferred transmission medium. In contrast, at the opposite end of the applications spectrum, there have been efforts to exploit variations in the same transmission parameters with respect to environmental disturbances in order to produce a range of fibre optic sensors. Such sensors would exhibit many potential advantages, usually for the same reasons as in communications, namely; electrical isolation, freedom from electromagnetic interference and the lack of fire risk in sensitive areas.

The range of parameters that can be measured can conveniently be classified into

—mechanical (force, pressure, deformation)
—electrical (field strength, polarization, current)
—magnetic (field strength, polarization)
—temperature.

In most cases these measurands produce changes in the refractive index or in the absorption of the fibre, but some of them will modulate luminescence effects. The table presents information on the categories of modulation and detection that may be used with each of the five different optical parameters.

Some of the most sensitive fibre sensors constructed use an interferometric technique in which the optical phase shift produced in a fibre by interaction with the measurand is compared to the phase of a reference arm. Rotation sensors (gyroscopes) with sensitivities around 10^{-2} degrees per hour are currently operating. Similar techniques can be applied to phase shifts produced by pressure changes on the fibre, resulting in acoustic hydrophone sensors with higher sensitivities than piezoelectric types. Magnetic fields can also be detected by phase techniques if the optical fibre is coated with a magneto restrictive material.

Mechanical displacement can be measured by several arrangements of intensity sensing between movable fibre ends, either with an orthogonal or a slant cut. Vibration detection of a movable membrane from reflected light is also popular. One of the most widespread uses of amplitude detection is the sensing of a Gray code from an encoded disc or shutter, with resolutions available down to 10μm. Finally, modulated microbending loss can be used by clamping a fibre between two plates with a periodic mechanical grating. In general amplitude detection methods are less sensitive than phase modulated sensors and in addition suffer from unwanted and variable signal attenuation and temperature problems.

Optical modulation and detection schemes, as classified in an informative survey of fibre-optic transducers (ref.5).

Parameter	Mechanism	Detection	Examples
Coherence	Interference between signal and reference fibre, or different propagation modes in multi-mode fibres.	Fringe counting or phase shift detection.	Fibre gyroscope, hydrophone multimode gauge for dynamic strain measurement.
Amplitude	Modulation of transmitted light by absorption, emission or refractive index change.	Analogue or digital.	Strain/pressure gauge using modulated micro-bending loss. Optical encoders.
Wavelength	Spectral dependent variations of absorption, emission and refractive index.	Amplitude comparison at two fixed wavelengths, or analogue signal for scanned wavelength.	Temp. measurement by · variable Fabry-Perot cavity · birefringent crystal · semiconductor bandgap shift
Time Resolved	Transient absorption or emission behaviour. Transit time of closed fibre loop with feedback.	Time-delay pulse analysis.	Temperature gauge by time decay of rare earth ion fluorescence. Nuclear radiation diagnostics using Cerenekov light.
Polarization	Changes in the gyratory optical tensor.	Polarization analyser and amplitude comparison.	Faraday rotation magnetic field transducer for non-contact current measurements.

References
1. J. E. Midwinter, First generation trunk transmission systems: capabilities and limitations. *IEEE Journal on selected areas in Communications,* vol.SAC-1, 1983, pp.381-6.
2. E. Iwahashi, Trends in long wavelength single-mode transmission systems and demonstrations in Japan. *IEEE Journal of Quantum Electronics,* vol.QE-17, 1980, pp.890-6.
3. J. R. Fox, D. I. Fordham, R. Wood and D. J. Ahern, Initial experience with the Milton Keynes optical fibre cable tv trial. *IEEE Transactions on Communications,* vol.COM-30, 1982, pp.2155-62.
4. C. W. Tsend and B. U. Chen, D-Net, A new scheme for high data rate optical LANs. *IEEE Journal on selected areas in Communications,* vol.SAC-1, 1983, pp.493-9.
5. A. L. Harmer, Review of optical fibre sensors. IEE Colloquium on Optical Fibre Sensors, digest 1982/60, paper 1/1, London, 1982.

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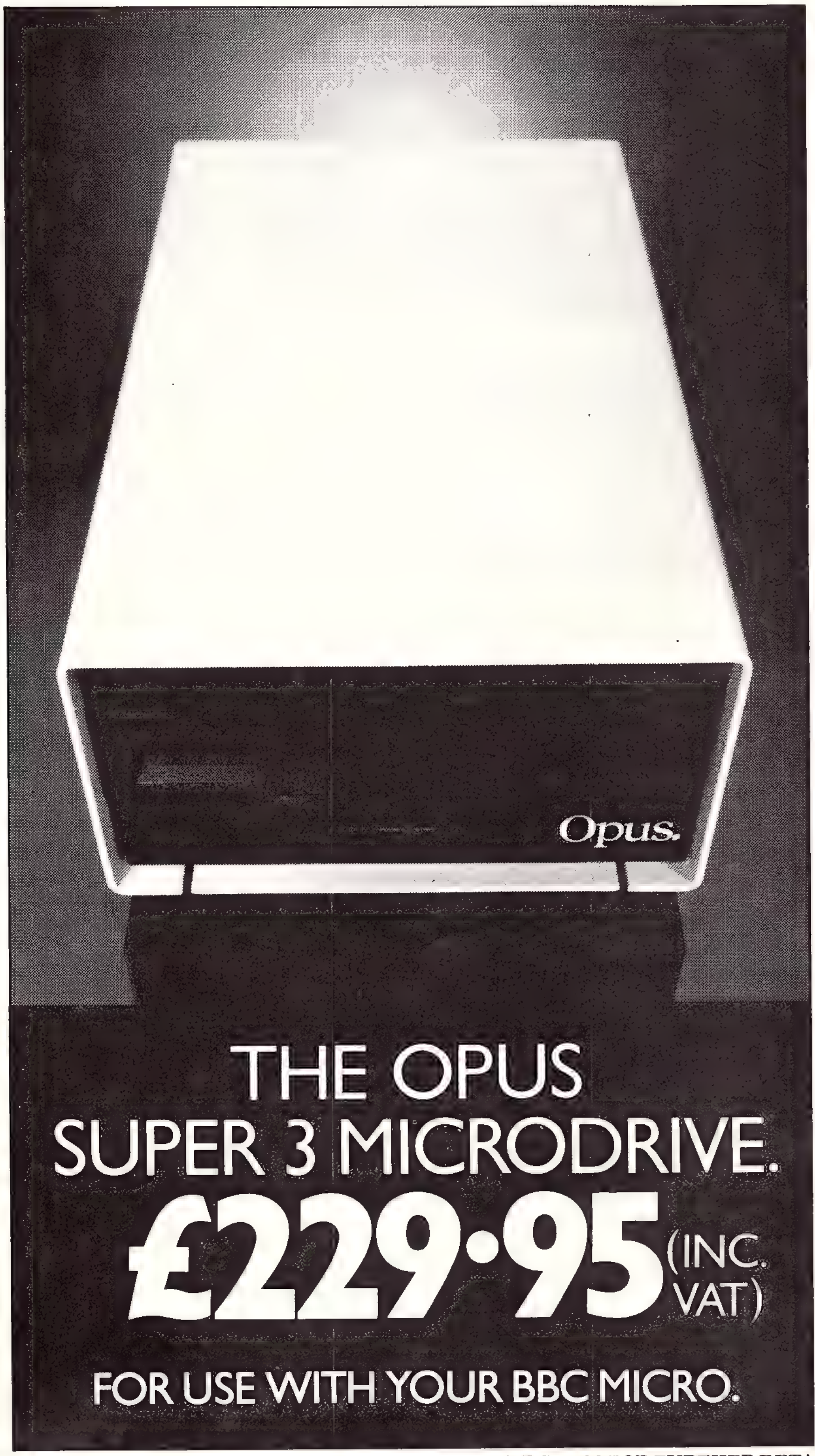

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CIRCLE 65 FOR FURTHER DETAILS.

Micro-controlled cassette recorder -2

by A.J. Ewins

Description of cassette recorder for use with microcomputer continues with description of f.s.k. modulator and demodulator.

The main criteria for choosing a suitable encoding technique for recording serial data from the output of a microcomputer (RS232 or t.t.l. levels) are, in my opinion, reliability, circuit simplicity and, perhaps most importantly, the ability to be used with any good set of recording/playback electronics. The microcomputer user is primarily concerned with reliability and ease of use of any encoding technique. He is not interested in very high speed techniques if half the time the data is recorded or played back incorrectly; or if the tape-recorder settings need constant adjustment.

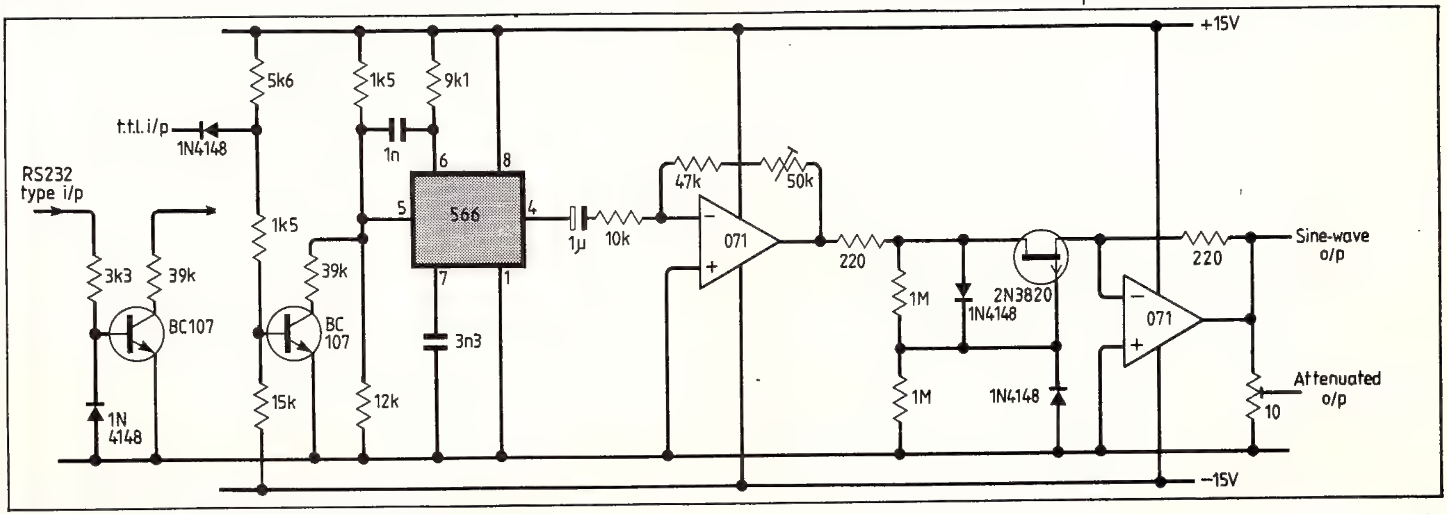
There have been a number of designs in various electronic magazines for 'high' speed recording techniques. The fastest of these, of which I am aware, was for 4800 baud. I also have had some experience of designing suitable encoding techniques for high speed serial data recording and am therefore very aware of the problems. Readers may recall the series of articles, in this magazine, on a digital multichannel tape recorder. In this design I achieved a rate of 22,000 baud using complex, but well known, techniques called Miller or delay modulation. However, all these very high speed designs, including my own, rely on the ability to record single high/low or low/high signal transitions. The success or otherwise of the technique depends not only on getting the 'electronics' right but also on tape quality *and* the mechanical operation of the cassette deck. It is very sensitive to imperfections in the tape quality, dirty tape-heads and indifferent transport of the tape across the head. In my opinion the techniques are unlikely to be successful unless only the best tapes are used, the cassette deck is of the highest quality, and the tape-heads are regularly cleaned.

A technique that is *far* less sensitive to these three sources of error is frequency shift keying. Using a few modern i.cs, a voltage-controlled oscillator and a phase-locked loop, a modulator and demodulator are easily designed that are easy to set up and reliable in use. In f.s.k., the output of an oscillator is simply switched between two frequencies; to represent the low and high logic states. There is a maximum rate at which the switching between the two frequencies can take place; somewhere between a fifth and a tenth of the mean of the two frequencies is a good rule-of-thumb. Using a good set of record/playback electronics I set my sights cautiously on a mean frequency of 10kHz, i.e. 9kHz and 11kHz for the 'low' and 'high' frequencies. A bit rate of 2400 has a highest frequency content of 1200Hz when a train of successive ones and zeros are being transmitted. Thus this figure was taken as the highest rate that could be easily be transmitted using the two nominal frequencies of 9kHz and 11kHz. (Actually, by pushing the mean f.s.k. frequency up to 12kHz and careful design of the demodulator stage, it should be possible to record at 4800 baud. Alternatively, it should be possible to drop the mean frequency to 6kHz and still be able to record at 2400 baud.)

F.s.k. modulator & demodulator circuits

The circuits of the f.s.k. modulator and demodulator are shown in Figs 6 and 7. I claim no originality

Fig. 6. **F.s.k. modulator, based on Signetics circuits but with triangle to sine converter for greater flexibility in choice of record/playback circuitry.**



for these, being but a variation of circuits published by Signetics in their book on the 566 (v.c.o.) and 565 (p.l.l.) integrated circuits. To the circuit of the modulator I added a triangular-to-sine waveform converter. This makes the circuit capable of being used with a much wider range of cassette deck recorder/playback electronics, overcoming some of the problems associated with the high-frequency pre-emphasis circuitry. The triangle-to-sine wave converter is also a variation of a circuit to be found in the Signetics book. It is possible to adjust the sine wave, total harmonic distortion, to less than 1% by setting the amplitude of the triangular waveform correctly.

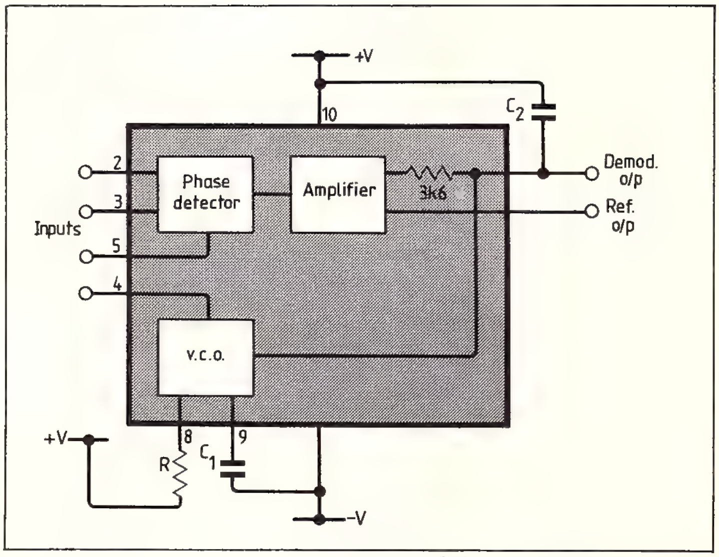


Fig.8. **Internal layout of 565 p.l.l.**

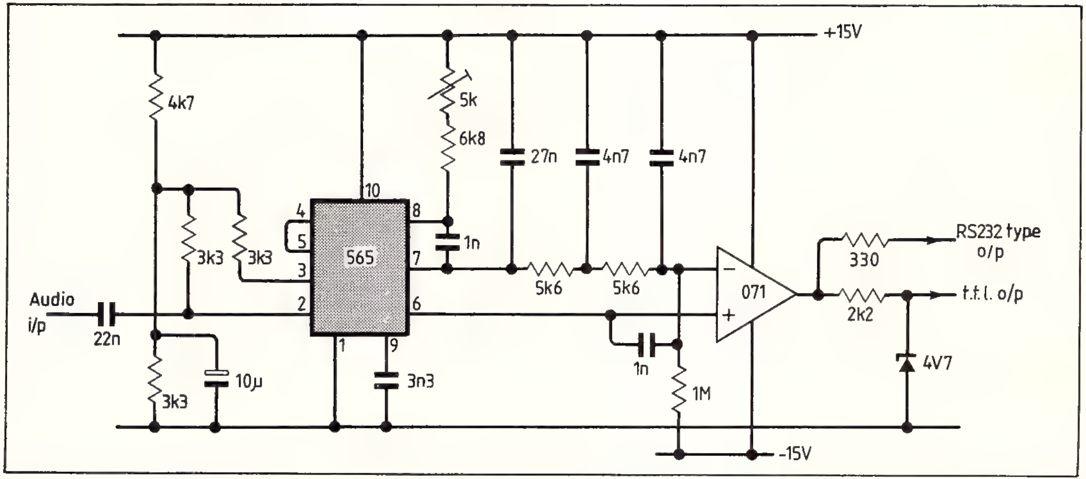


Fig.7. **F.s.k. demodulator, using Signetics 565 phase-locked loop.**

The heart of the f.s.k. modulator (Fig.5) is the voltage controlled oscillator i.c. the 566. These i.cs are designed to operate with a nominal voltage on their modulation input, pin 5, of $V_s/8$ below the positive supply rail, i.e. $7V_s/8$. A modulation of this voltage by ±10% produces a modulation of the frequency output by the same amount. For a V_s, of 15V, $V_s/8$ is 1.875V. Plus and minus 10% of this value gives voltages of approximately 1.69 and 2.06V below the positive supply rail, i.e. actual voltages on pin 5 of 13.31 and 12.94V. the 1.5kΩ and 12kΩ resistors produce a nominal voltage on pin 5 of 13.33V. When the transistor is conducting the 39kΩ resistor is effectively in parallel with the 12kΩ, reducing the effective resistance to about 9.2kohms. The voltage on pin 5, when the transistor is conducting, is thus reduced to a nominal value of 12.90V. Thus by switching the transistor on and off the voltage on pin 5 is modulated by ±10% about its centre value of 13.125V. The input stage to the transistor has been designed for either t.t.l. levels (between 0 and 5V) or RS232 type signals (±3 to ±15V). If both types of input are required there is no reason why two transistors should not be used with their collectors sharing a common 39k± resistor. It is, of course, important that the transistor of the unused input be in its off-state, i.e. non-conducting.

Apart from the voltage on pin 5, the frequency-determining components of the 566 i.c. are the 9.1k ohm resistor on pin 6 and the 3.3nF capacitor on pin 7. With these chosen values, the output frequency for a voltage of 7 $V_s/8$ on pin 5 is $f=1.2/(4RC)$, i.e. 9990Hz. Thus, when the logic level on the input varies between low and high, the frequency out put of the 566 i.c. varies between about 9 and 11kHz.

The output from pin 4 of the 566 i.c. is a symmetrical triangular waveform of about 3V pk-pk with a positive d.c. bias voltage. The triangle-to-sine wave converter needs quite a large voltage drive and the variable gain stage is included for this purpose. The triangle-to-sine wave converter uses the non-linear I_{DS} - V_{DS} transfer characteristic of a p-channel j-fet to shape the triangular waveform: The output from it is a little less 1V, r.m.s. with a distortion factor of less than 1% when the input amplitude is correctly adjusted. A distortion meter is the only proper way of achieving the minimum distortion figure, but visual inspection using an oscilloscope can produce a good enough result. A variable or fixed attenuator is used to reduce the sinewave output voltage to a level suitable for recording on the cassette deck's record/playback electronics.

The circuit of the f.s.k. demodulator is shown in Fig.7, the heart of which is the 565 phase-locked loop. There is nothing unusual about its design but a few comments will be made so that its operation may be understood. The phase-locked loop consists of a voltage-controlled oscillator (an identical v.c.o. to that used in the 566 i.c.), a phase-sensitive detector and an amplifier with a single stage of low-pass filtering. The interconnection between the various elements of the p.l.l. is shown in Fig.8. When the frequency of the v.c.o. is locked to that of the incoming signal, the output from the phase detector (amplified and filtered) applied to the input of the v.c.o. is that voltage which the v.c.o. requires to produce the particular frequency. The voltage applied to the input of the v.c.o. is also the demodulated output signal that we require. For the v.c.o. to produce a different frequency output, the voltage on its input will have to change. This is exactly what the p.l.l. achieves; when a signal of a different frequency is applied to the input of

Continued on page 67

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WW 16

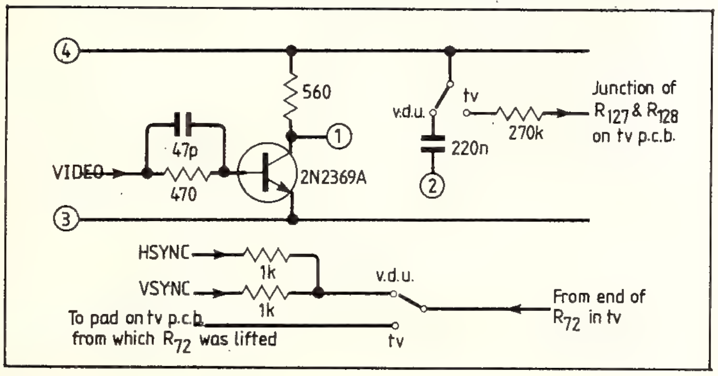
CIRCLE 34 FOR FURTHER DETAILS.

SC84 microcomputer

continued from page 34

output is captured in an eight-bit latch, IC_{305}, by the trailing edge of the next carry pulse and held during the next memory cycle. This allows the eprom to produce the dot pattern for character zero while character one is being brought from memory. The trailing edge of the next carry pulse occuring 500ns later allows plenty of time for the eprom to submit a dot pattern. This pulse enables parallel loading of the shift register IC_{307} used to convert the dot pattern from eprom into a serial stream of pixels. Being synchronous, the shift register does not load the dot pattern until the rising edge of the dot clock, which occurs while the load input is low. This edge occurs just before the end of the carry pulse and might not, at first, appear to be consistent with the synchronous philosophy propounded earlier as there is an undefined delay between this clock edge and ending of the carry pulse. Note though that it is this same clocking edge which advances the synchronous counter and thus ends the carry pulse, which must therefore change after the rising edge of the clock. Also, the required holding time for the loading signal after shift register clocking is zero and the clocking signal is from a Schottky gate with a very fast rise time, so the loading of data is assured. With this data stored in the shift register the trailing edge of the carry pulse loads a new value from v.d.u. memory into IC_{305} and the cycle repeats. This means that pixel output begins two character periods after the start of a scanning period. As mentioned earlier, the controller also supplies some direct video-control signals, one to enable the display (so that the screen may be blanked during non-display periods such as during flyback) and a second to indicate when the character position being accessed corresponds to the setting of the controller cursor register. As with M lines, these signals will be delayed and, taking the example of the display-enabling signal, they must be delayed by one and a bit character periods if they are to become active just as pixels for the first character on the line are clocked out of the shift register. One enhancement made to the Hitachi 6845 is that it is possible to delay the output of these two control signals by one or two character periods, which saves on i.cs. These signals are given a one character-period delay and synchronized by a two-bit latch, IC_{315}, which is also clocked by the carry signal.

Fig. 2. A monitor is best for high density text display but a monochrome tv set with minor alterations can give satisfactory results. This modification for Ferguson/Ultra 3840, 3845, 3847, 3848, 6840 and 6845 tvs allows the set to be switched between computer input or broadcasts. Numbers in circles refer to pins on the cathode-ray-tube controller socket. The tv circuits must be isolated from the mains (see text).



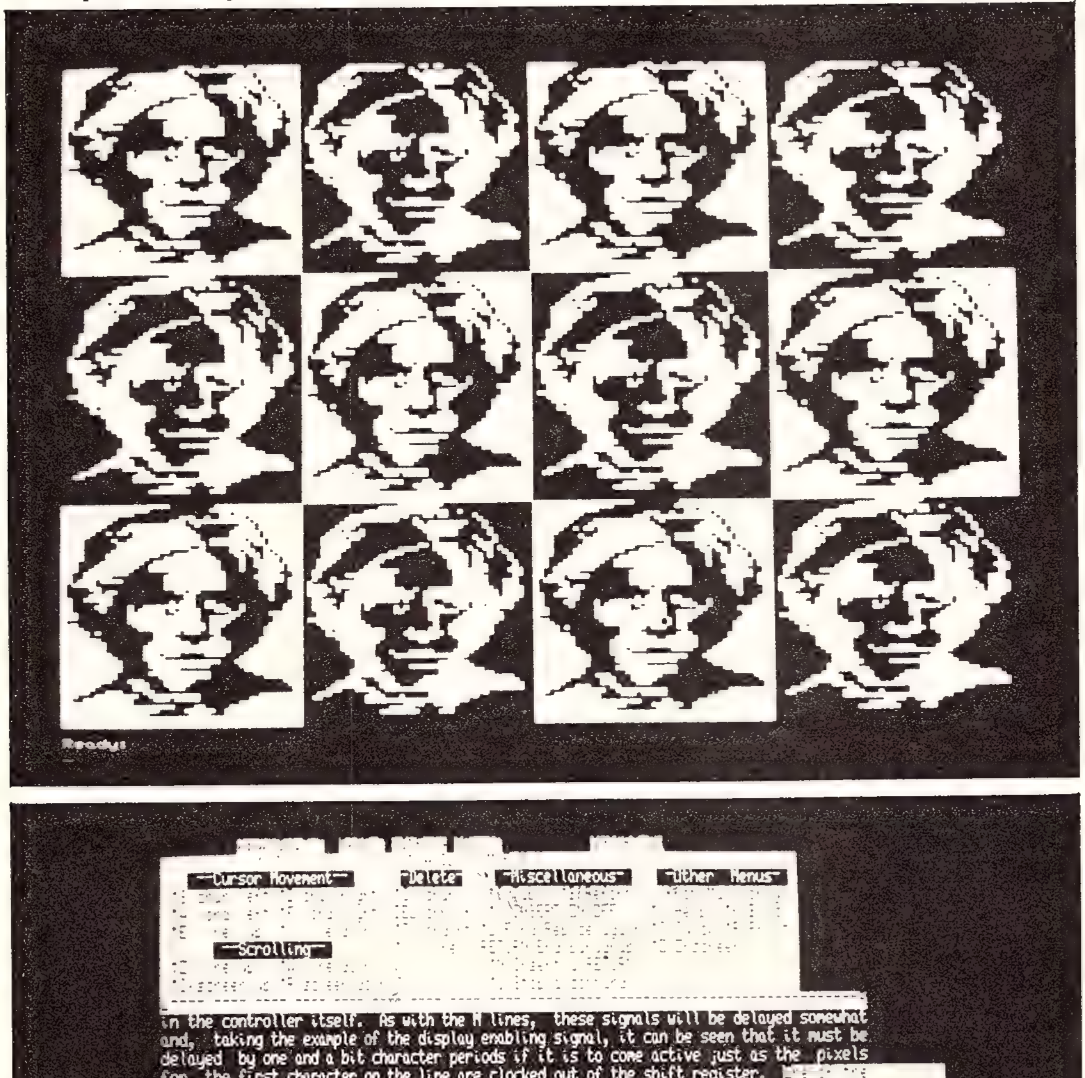
At the other end of the system, the 74LS85 four-bit comparator produces a signal at pin 6 when $A_{13,14}$ and VDUSEL are low and A_{15} is high, i.e. an address on the address bus is in the range 08000 to 09FFF and the v.d.u. memory is switched into the memory. Note that the four matching comparator inputs are switched so it is possible to relocate the area in memory at which the v.d.u. appears (switch on=low). The address is set up before MREQ by the Z80 so the comparator signal can activate MEMDIS to inhibit a system-memory cycle. Further decoding is necessary though to ensure that this is a memory cycle; MREQ is gated so that v.d.u. signal SEL only goes low during a true v.d.u. memory access. Select signal SEL does several things. It switches the four 74LS157 multiplexers so that they direct bus address lines into the v.d.u. memory and connect the system WR signal to the memory and HD6845S. The v.d.u. memory and the 6845 are always selected so they would be incorrectly written to if WR wasn't gated. It also enables the data-bus buffer and clocks a set/reset latch made from half of an 74LS00. When set, this latch clears the 74LS273, forcing a display of one dot-row of the character generator corresponding to code 000 — which happens to be blank. The latch is reset by the character clock. This latch suppresses the speckling effect mentioned earlier, the algorithm being 'any c.p.u. access during the fetching of a character code to the character latch forces character code to zero'. While it might seem simpler to gate SEL directly with the video output to produce blanking, due to the pipelining technique SEL would blank the display between one and two characters too early.

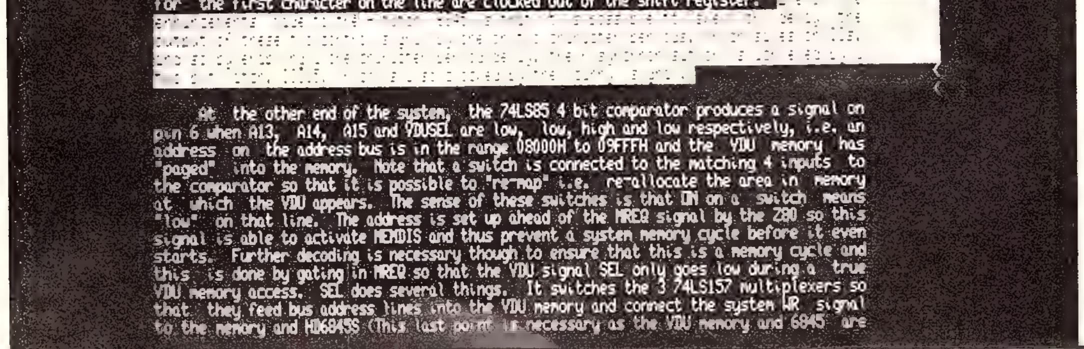
The v.d.u. memory consists of 6Kbytes of static memory. Address and data lines to the v.d.u. memory i.cs do not correspond to their specified 'A' or 'D' numbers but this doesn't matter. The order used was chosen to ease p.c.b. layout. After all, if a data byte is written into memory with a particular addressing pattern, that same byte will be accessed when the same address is applied. The lower 11 bits of the address supplied by the multiplexers are fed to all three memories in parallel. The next two most-significant bits of the address feed a decoder which activates one of four output lines. The four lines pass to the memory i.c. enable inputs and the 6845 so that within the addressing range 08000 to 09FFF for which SEL is active, the memory is mapped at addresses 08800 to 09FFF and the 6845 control registers from 08000 to 087FF. Effectively, the 6845 only needs two locations, one to receive the number of the internal register that the c.p.u. wants to access and one which appears as that register. The fact that it has been allocated another 2046 in the rather coarse decoding is not a loss though, and it simplifies both hardware and software. The standard rom supplied programs the system for standard timing signals and a display consisting of 32 rows of 96 characters each. This means that only 32 by 96, or 3Kbytes, of v.d.u. memory is required and, for the basic system IC_{304} may be omitted. 6Kbytes of memory is needed though to work with the higher resolution graph plotting mode provided in Basic which reprograms the 6845 to scan twice as much memory and produce a display of 64 rows of 96 characters. In graph plotting with the character v.d.u., the split-screen plotting area is 192 by 180.

Connecting a monitor

A 30cm-screen monitor is about optimum. Synchronizing and video signals may be inverted to suit your requirements. For the switches controlling the sync. signals, S_{305} and S_{308}, on provides negative-going syncs, whereas switch sections S_{306} and S_{307} select either positive or negative-going video; note that these two switches must not be on at the same time. The dense display makes a stringent requirement on the monitor but standard types with bandwidths of 15MHz or more should be satisfactory. As a cheaper alternative, a television may be modified. This does not stop the set being used as a tv but does require some simple internal modifications. Following details show how to adapt a Ferguson 3845, which is the type used by most of the present Scientific Computer group, and give guidance for modifying other models. Make sure that the set you choose is one with an isolated supply, i.e. that there is no electrical connection between the mains and internal tv circuits, or use an external isolation transformer. The Ferguson set has a double-wound mains transformer — as do many portable tvs nowadays — but check to make sure if you use a set other than the 3845. Apart from the risk to yourself if you use a live-chassis set, you stand a good chance of permanently reprocessing large amounts of expensive circuitry should something untoward occur.

From the circuits in the tv set, Fig.2, find where the sync. signal is separated from the video, the polarity of the sync. signal, the cathode and grid pins of the c.r.t. socket, which of the two is driven with video, and the potential on the other. In the case of the 3845 these points are the end of R_{72} nearest the back of the set, negative sync., pins two and one respectively, the cathode and zero volts. Modifications required are to break the sync. signal path within the set, in this case by unsoldering and lifting away the end of R_{72}, and remaking the path with one half of a two pole change-over switch, the other input of which is a combination of the two sync. signals. The other half of the switch is used to connect a decoupling capacitor to





```
in the controller itself.  As with the H lines,  these signals will be delayed somewhat
and,  taking the example of the display enabling signal, it can be seen that it must be
delayed  by one and a bit character periods if it is to come active just as the  pixels
for  the first character on the line are clocked out of the shift register.

     At  the other end of the system,  the 74LS85 4 bit comparator produces a signal on
pin 6 when A13,  A14,  A15 and VDUSEL are low,  low, high and low respectively, i.e. an
address  on  the address bus is in the range 08000H to 09FFFH and the  VDU  memory  has
"paged"  into the memory.  Note that a switch is connected to the matching 4 inputs  to
the comparator so that it is possible to "re-map" i.e.  re-allocate the area in  memory
at  which  the VDU appears.  The sense of these switches is that ON on a  switch  means
"low"  on that line.  The address is set up ahead of the MREQ signal by the Z80 so this
signal is able to activate MEMDIS and thus prevent a system memory cycle before it even
starts.  Further decoding is necessary though to ensure that this is a memory cycle and
this  is done by gating in MREQ so that the VDU signal SEL only goes low during a  true
VDU memory access.  SEL does several things.  It switches the 3 74LS157 multiplexers so
that  they feed bus address lines into the VDU memory and connect the system WR  signal
to the memory and HD6845S (This last point is necessary as the VDU memory and 6845  are
```

SC84

Processor
4/6MHz Z80 processor.
Maximum 64K-byte ram.
58K-byte ram available using SciDOS.

Display
Up to 32 lines of 96 characters full programmable. Scrolling window determined by software.
Graphics mode 0 gives 192 by 96 pixels, mode 1 gives 192 by 192 resolution. Characters and graphics may be displayed simultaneously.

Input/output
Up to four single or double-sided 8, 5.25, 3.5 or 3in disc drives may be used, either single or double density.
RS232 serial i/o data rates range from 1 to 38400baud with separate transmit/receive clocks. Synchronous serial i/o format is 5 to 8-bit auto-search and sync. or asynchronous 5 to 8-bit with 1, 1.5 or 2 stop bits. RTS and CTR signals conrol serial data flow.
Eight-bit parallel data input is buffered by schmitt i.cs. Eight-bit parallel output drives five t.t.l. loads.
The mos i/o lins operate event counters, pulse timers and Z80 interrupts. Four mos timer lines are available for timing and sound generation.

A set of three Eurocard-format plated-through-hole boards for SC84 is available from Combe Martin Electronics, King Street, Combe Martin, Devon EX4 0AD. Price is £39 for the set including v.a.t. and inland or overseas postage. John Hodson — secretary of the Scientific Computer User Group — is organizing the SC84 user group. For further information, send an s.a.e. to him at 12 Broughton Road, Basford, Newcastle-under-Lyme (new address). A listing of SC84's machine-code operating system — MCOS — can be obtained by sending an s.a.e. to *Electronics and Wireless World*, Room L303, Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS.

Keyboard and parallel i/o interfacing

Keyboard requirement is for a source of seven-bit ascii code with a positive-going level strobe, i.e. one which stays high as long as a particular key is pressed (circuit shown last month). As ascii is a seven-bit code, the eighth input bit is not wasted but used as a flag that the RS232C port is to echo v.d.u. program output when using MCOS. Not all keyboards have an auto-repeat function so it is provided on the board; an interrupt pulse is sent to the STI at the start of the strobe pulse and after a pause of approximately 0.5s further pulses occur at approximately 20Hz. Overall speed of the repeat system may be adjusted by changing the 1µF capacitor value, the 0.5s hold-off only may be adjusted by altering the 390kΩ resistor and the repeat frequency by altering the 1.8kΩ resistor. In all cases, reducing the value increases the speed of operation. The i.c. used for keyboard repeat, IC_{209}, also supplies the 2.4576MHz signal for bit rate generation. I recommend that you avoid a National Semiconductor part for this i.c., CD4093BE (RCA) or MC14093BCP (Motorola) being suitable.

Table 2. Interrupt vectors in memory.

Address	Service routine
0FF00	I/O line 0 (keyboard interrupt)
0FF02	I/O line 1
0FF04	I/O line 2
0FF06	I/O line 3 (pulse width/event B)
0FF08	Timer D
0FF0A	Timer C
0FF0C	I/O line 4 (pulse width/event A)
0FF0E	I/O line 5
0FF10	Timer B
0FF12	Transmit error
0FF14	Transmit buffer empty
0FF16	Receive error
0FF18	Receive buffer full
0FF1A	Timer A
0FF1C	I/O line 6 (disc controller INTRQ)
0FF1E	I/O line 7 (disc controller DRQ)

These are addresses of the two consecutive locations in memory at which the interrupt controller will expect to find the starting address of the service routine for that particular interrupt.

Table 1. Nominal allocations of Z80 i/o ports.

Port address (hex.)	Allocaton
0E0-3	Keyboard input and control port output
0E4-7	General purpose parallel i/o
0E8	Disc controller command and status port
0E9	Disc controller track register
0EA	Disc controller sector register
0EB	Disc controller data register
0EC-F	Not used
0F0	STI indirect register
0F1	STI parallel i/o port
0F2	STI interrupt pending register B
0F3	STI interrupt pending register A
0F4	STI interrupt inservice register B
0F5	STI interrupt inservice register A
0F6	STI interrupt mask register B
0F7	STI interrupt mask register A
0F8	STI pointer/vector register
0F9	STI timers A and B control register
0FA	STI timer B data register
0FB	STI timer A data register
0FC	STI usart control register
0FD	STI receiver status register
0FE	STI transmitter status register
0FF	STI usart data register
000	STI sync. character register
001	STI timer D data register
002	STI timer C data register
003	STI active edge register
004	STI interrupt enable register B
005	STI interrupt enable register A
006	STI data direction register
007	STI timers C and D control register

Wire links from ground pin TP_{201} to TP_{202-4} select addresses of the i/o ports. The i/o allocation used in the system software is given in Table 1. Links need only be included should these be changed for experimental purposes. If this is not envisaged, they may be left out altogether.

Parallel i/o is catered for by uncommitted eight-bit input and eight-bit output ports, a control port used for keyboard input, and output to the disc drives and system. There is an option for the eight-bit parallel output port, IC_{206}. Use a 74LS273 and make link 202 for a standard eight-bit port which is automatically cleared on RESET, or use a 74LS373 and make link 201 for a tri-state port enabled by applying a low level to pin one of the port connector. The latter option means that this port may then be connected in parallel with the eight-bit input port to form a bidirectional i/o port. Spare I lines on the STI, pins 11 to 13, are also available from pads adjacent to the i.c. pins as are the outputs from the four frequency generators. Link 203 should be wired in on the basic system but may be removed to free pin 16 of the STI for use in an interrupt daisy-chain, Table 2.

the driven pin, the cathode in this case, to suppress the tv video signal in computer monitor mode. In the 3845, a resistor is also connected to this switch and to the junction of R_{127}, the height control, and R_{128} which, looking at the back of the set, is the leftmost terminal of the height control. This allows automatic adjustment of picture height to the optimum for tv and computer.

The video signal is brought in on a short length of screened cable and buffered by a 2N2369A transistor before being applied to the tube grid. All connections are made through the tube socket, the prototypes being about 1in square pieces of Veroboard mounted directly on the back of the tube socket. This is the recommended position as long wires will ruin the video quality. When making this interface, remove the tube socket from the tube while soldering and use stiff wire to mount the interface board onto the socket and flexible wire (including the screened wire) to link from it to the switch, etc., in order not to put strain on the socket and c.r.t. neck. Most portable sets have the 3845 type of circuit where the cathode is driven and the grid is at zero volts. If neither the grid nor cathode is at a low potential then some form of level-shifting must be used or, better, a different type of set considered.

Normal settings for S_{301-4} are off-off-on-on, mapping the v.d.u. at hexadecimal addresses 0800-09FFF, switched in by VDUSEL being high. Other permutations are possible for experimentation.

SC84's disc-operating system, SciDOS, with utility software costs £36 extended Basic with graphics is £22.50 and Basic with enhanced file manipulation, i/o control, numeric/constant string handling and 12-digit precision is £31.50. These prices include v.a.t. and postage and become £24, £15 and £21 respectively for non-commercial users and further discounts are available for those buying more than one software package at once. John Adams is considering producing a kit of i.cs for SC84. For details of these items send an s.a.e. to him at 5 The Close, Radlett, Herts.

A switch-regulated power supply and further constructor's notes are subjects of a future article.

CASSETTE RECORDER

Continued from page 62

the p.s.d. the output voltage changes to drive the v.c.o. to the new frequency.

Operation of the phase-locked loop is exactly analogous to a servo-loop; it has a natural frequency, damping factor and a bandwidth with a second order, low-pass filter characteristic. Effectively what the p.l.l. does is to recover, from the frequency of the input signals, the original changes in voltage that drove the v.c.o. in the modulator. As the v.c.o. of the p.l.l. is identical to that of the 566, it is not surprising that the changes in voltage levels at the output of pin 7 are similar to those applied to the input of the v.c.o. of Fig.6. The voltage change applied to the v.c.o. of the modulator was 430mV (13.33-12.9); the voltage output from the 565 (pin 7) is thus of the same order.

The maximum operating voltage of the 565 i.c. is 26 volts. It cannot therefore operate from the ±15 volt supply rails and was consequently chosen to operate from the +15 volt supply rail and ground. (±15 volt supply rails were chosen because of the large voltage drive required by the triangle-to-sine wave converter of Fig.6; it will not operate satisfactorily from ±12 volt supplies.) The two inputs of the 565 i.c. pins 2&3, require an identical d.c. bias that is slightly less than the half-supply voltage. The potential divider consisting of the 4.7kΩ resistor and 3.3kΩ resistors produces the required d.c. bias on pins 2 & 3 via 3.3kΩ series resistors. The audio input may be to either of these two inputs, via a suitable decoupling capacitor. As the lowest audio signal frequency is not less than 9kHz, the decoupling capacitor may have a conveniently low value of 22nF.

The components that determine the free-running frequency of the v.c.o. of the 565 i.c. (which should be the centre frequency of 10kHz) are the resistor on pin 8 (a 6.8kΩ resistor in series with a 5kΩ variable) and the capacitor on pin 9. The values chosen are the same as those for the v.c.o. of Fig.6, except that the resistor is made adjustable. For a ±10% frequency deviation, the amplitude of the audio input signal can vary from 10mV to 1V r.m.s., and still maintain good tracking of the input frequency. The volume setting of the record/playback electronics on playback of the recorded signal is thus non-critical and a mid-way setting of 100mV r.m.s. ideal.

The expected direct voltage variation on the output of pin 7 for an input signal with frequency deviation of ±10% is, as mentioned earlier, about 430mV. This can be adjusted to ±215mV about the reference voltage level on pin 6 by adjusting the value of the 5kΩ variable resistor. This is most easily achieved by connecting the output of the modulator to the input of the demodulator and applying logic low and high levels to the modulator input.

The output from the demodulator, pin 7, which is applied (internally) to the input of the v.c.o. needs to be filtered for the p.l.l. to operate satisfactorily. This is achieved in this circuit by the 27nF capacitor connected between pin 7 and the +15V supply rail. For the chosen v.c.o. operating frequency of 10kHz and a rate of 2400 baud this value has been found to be satisfactory. It is also satisfactory for lower rates, but possibly not for a higher rate of 4800 baud. (Unfortunately I have not been able to try this out.)

To provide a t.t.l. and RS232 type output level, the output from the demodulator, on pin 7, needs to be amplified. This is achieved using an op-amp, as a comparator and the output from pin 6 as the reference level. The output from pin 7 is further filtered by the simple two-stage ladder filter composed of 5.6kΩ resistors and 4.7nF capacitors. The band-edge of the ladder filter is chosen to be approximately half way between the maximum keying rate (2400 baud or 1200Hz) and twice the input frequency (about 20kHz).

The 1nF capacitor connected between pins 7 & 8 acts in the same way as that between pins 6 & 5 of the 566 i.c.; i.e. to improve high-frequency stability. Similarly, the 1nF capacitor across the inputs of the op-amp comparator does the same thing. The 1MΩ resistor connected from the inverting input of the op-amp to the -15 volt rail ensures that a logic high level is output from the op-amp when *no* audio signal is present on the input to the demodulator. Two outputs are provided from the op-amp, one at t.t.l. levels suitable for coupling directly to t.t.l. i.c. inputs, and one at an RS232 type level.

I must confess, at this point, that although I have shown the modulator and demodulator circuits of Fig.6 and 8 with RS232 type inputs and outputs, I have not tried them out on my own computer, preferring to use t.t.l. levels. It is my understanding that RS232 type inputs and outputs normally invert the t.t.l. logic levels. In so far as I have shown the RS232 type inputs and outputs being used, this should not matter since, if the modulator is connected to the demodulator then a 'high' input on the modulator will produce a 'high' output from the demodulator. However, in the absence of an audio signal input to the demodulator the t.t.l. output should be high. If the RS232-type connection is used on the output of the demodulator, this will also be high. A subsequent RS232 input on the microcomputer may invert this to a logic low on its t.t.l-type output. To invert this logic, the 1MΩ resistor connected between the negative input of the op-amp comparator and the -15 volt supply rail should be connected to the +15 volt supply rail instead. A final article will describe the up/down tape counter and record/playback electronics.

LITERATURE RECEIVED

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A CNC lathe which can be controlled from a BBC micro is produced by Colne Robotics and described in a leaflet. Included is the basic software which provides a comprehensive range of control codes to program and retain complex cutting sequences. Safety measures are provided by hardware safety cut-out switches and from within the software. Colne Robotics Co. Ltd, Beaufort Road, off Richmond Road, Twickenham, Middlesex, TW1 2PQ. WW271

A range of small p.c.bs, each with elements of a circuit can be linked together to make up more complex circuits. This is the Alpha system from Unilab. It is designed to be a 'low-cost, radical approach to the effective teaching and learning of basic electronics, initially for the 13+ age range.' There is also a range for more advanced work. Details supplied in a leaflet from Unilab, Clarendon Road, Blackburn, Lancs BB1 9TA. WW272

The functions of many different instruments are combined into one unit in the Griffin programmable scientific instrument, or GiPSI. Starting from a single or dual-input multimeter it may be converted into a variety of other instruments by the addition of plug-in modules and overlays to show the functions of the touch-sensitive membrane keyboard. Among the modules are a pH meter, measurements of pressure, magnetic flux, timing and counting, and many more. The meter can also be interfaced with a computer as part of a data acquisition system. Full details in a brochure from Griffin & George, 285 Ealing Road, Wembley, Middlesex HA0 1HJ. WW273

A number of programs for biological experiments are included in *Micros in the Lab*. Designed for use with the ZX Spectrum computer, full software and hardware details are given in this duplicated booklet. The centre that publishes it can also supply a number of components to ILEA schools. ILEA South London Science Centre, Wilson Road, London SE5 8PD. Telephone: 01-701 2224.

ILEA publish two magazines for school micro users–Computers in Primary Schools newsletter for primary schools and Educational Computing for secondary schools. Both come from the Inner London Educational Computer Centre, John Ruskin Street, London SE5 0PQ. WW275

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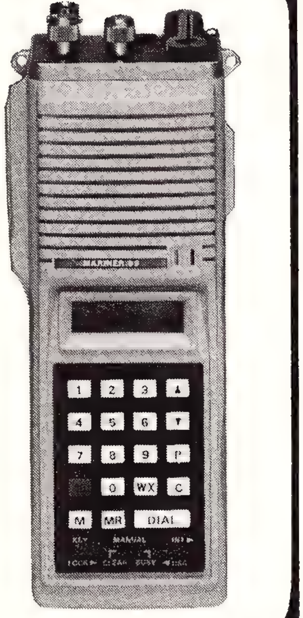

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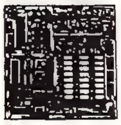

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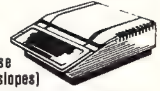

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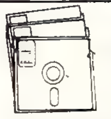

SOFTWARE

MDIS (C) INTELLIGENT DISASSEMBLER
For all CP/M based machines **£50.00**

IVC HI-RES (C) For Gemini and others (please enquire). Provides Pseudo high resolution graphics **£15.00**

DISKPEN(C) Version 3. Low cost word processor for Gemini and others (please enquire) **£50.00**
Plus large range or overlays for Diskpen.

HENRYS CP/M UTILITIES DISK (C)
41 Programs for the CP/M Systems programmer

5¼" format	£15.00
8" format	£17.35

Ask for details on all of above. WHEN ORDERING PLEASE SPECIFY FORMAT REQUIRED.
Contact Computer Dept. if uncertain.
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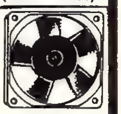
All above available to retailers and distributors – contact Computer Dept. for details.

COMPUTER POWER SUPPLY

Switched mode. Stabilised. Self protecting. S/C protected. etc. 220/240V AC, +5V 3.3A, +12V 2.4A 40% cycle, –5V 0.5A, –12V 0.5A. Suitable Apple replacement **£50.00**
(UK C/P £1.50)

COMPUTER FANS



CU7983 115V 50/60Hz
12/13W Impedance protected
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Two for **£8.70** (UK C/P 70p)
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NEW LOW PRICE

COMPLETE WITH FULL HANDBOOK. 3 ROLLS PAPER **£43.43**
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16 button key pad non-encoded
£5.17 (UK C/P 30p)

MODEM CARDS/ COUPLER

Brand new, tested, answer and originate 300 BAUD uncased acoustic modem card by famous manufacturer. RS232 input/output. Power supply +/– 12V at 180mA. Requires 2 magnetic earpieces, 2 switches, 2 LEDs and connectors to complete. Circuits and connection data supplied.

Card only	£26.04
Card and remainder of small components	£29.09

Telephone Direct Line coupler type LTU 11 MKII. Suitable for direct coupling PRESTEL adaptors and the above acoustic modems. Integral Line select and autodial relays requiring TTL inputs. Circuits and connection data supplied.
LTU 11 Coupler **£13.00**

1200 BAUD receive 75 BAUD send direct coupled modem for PRESTEL. Requires +5V supply with TTL inputs for data, line select and autodial. LTU 11 direct coupler required. See above. Connection data supplied.
PRESTEL modem card **£13.00**

STOCKISTS FOR Printers: Paper, Thermal, Daisywheel Disk Drives Boxed, Chassis also Winchester Monitors: Green, Orange, White, Colour. Micro's: BBC, Electron, Nascom, Galaxy. Plus others. Cables, plugs, blank disks & tapes, software, books, etc.

HENRY'S COMPUTER SHOP

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Official orders welcome.
(Subject to confirmation)

Please add 15% VAT
(UK only)
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Details available most models send SAE

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Advertisments accepted up to 12 noon Tuesday, July 31st for August/Sept. issue
subject to space available.

DISPLAYED APPOINTMENTS VACANT: £17 per single col. centimetre (min. 3cm).
LINE advertisments (run on): £3.50 per line, minimum £25 (prepayable).
BOX NUMBERS: £5 extra. (Replies should be addressed to the Box Number in the advertisement, c/o Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS).
PHONE: LUCY O'SULLIVAN, 01 661 3033 (DIRECT LINE)

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Due to expansion

Samuelson Video Equipment

Require a further

VIDEO ENGINEER

for bench and field work

Duties involve the maintenance and installation of professional video equipment. A candidate should be familiar with three tube colour cameras, U-Matic format video recorders and associated equipment.

Whilst a technical qualification is desirable, a minimum of five years experience is required. This is an interesting job requiring a high level of expertise and self-motivation.

If you can match up to these expectations we would like to hear from you.

Company vehicle provided, salary commensurate with experience.

Please contact Mr Stone or Miss Whittick on 01-450 1313

(2641)

CAMBRIDGE HEALTH AUTHORITY
ADDENBROKE'S HOSPTIAL,
HILLS ROAD, CAMBRIDGE. CB2 2QQ.

MEDICAL PHYSICS DEPARTMENT

GRADE III MEDICAL PHYSICS TECHNICIAN (ELECTRONICS)

An Electronics Technician is required to provide a wide range of support services within the Cambridge area. Duties will include maintenance repair and development of a wide range of equipment. The post holder will also be expected to provide support to the CT Head Scanner in conjunction with other staff.

Minimum qualification O TEC or equivalent but H TEC/ENC preferred, with at least 3 years experience. Applicants should hold a valid driving licence.

£6132 per annum rising to £7926 per annum (under review).

For further details contact Mr P E Ward, Principal Medical Physics Technician, at above address or telephone Cambridge 245151, ext. 471.

Application form/job description: Personnel Department at above address or telephone Cambridge 245151, ext. 7511.

Closing date— 15th August 1984. (2647)

ELECTRONICS ENGINEER

A vacancy exists in our Sound Installation and Maintenance Section at our Glasgow Studios for an Electronics Engineer who should preferably be qualified to degree HND/HNC level (or equivalent).

Preference will be given to applicants with experience in maintaining a wide range of professional broadcast audio equipment.

All salaries are due to be reviewed on 1st July, 1984, but the range is at present on the engineer grade from £7534-£10,665. The starting point on this range will depend on qualifications and experience. Thereafter the successful candidate will progress automatically to the top of the range by annual increments and he/she will also qualify for length of service increments after 2 years service.

Interviews will be held in Glasgow and travelling expenses reimbursed. Generous relocation expenses will be available to suitably qualified and experienced applicants where necessary.

The company operates an excellent pension scheme with free life assurance.

Men or women with the necessary experience and qualifications should write for an application form to **The Recruitment and Training Manager.**

STV is an Equal Opportunities Employer.

STV

Scottish Television
Cowcaddens, Glasgow G2 3PR.

BROADCAST ENGINEER

We are seeking applications from experienced Engineers with previous broadcasting experience to join our Engineering Department. A good working background is essential, plus the ability to drive.

If you feel you can offer the enthusiasm and experience that this position demands write to:

Dave Wood, Chief Engineer,
at BRMB Radio, P.O. Box 555, Aston Road North, Birmingham B6 4BX
giving details of your career to date.

BRMB
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Professional quality VHF/FM broadcast transmitters and repeater links available. 25-250 watts, all solid state, continuously rated. Mono/Stereo versions. High stability PLL/Xtal references. Competitively priced ie 100 watt model, with integral mains power supply — £375 Fully guaranteed.

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(2652)

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TECHNICAL TRANSLATION (GERMAN/FRENCH TO ENGLISH) send sample page for translation and quote to: Young, 23 Raymond Road, Norwich NR6 6PN. (2654)

BILLINGTON VALVES July 84 Catalogue now available. Send 35p for listing of top quality, guaranteed, valves, bases + components, or S.A.E. for prompt quotation. We purchase valves; any quantity, vintage or modern. Billington Valves, Irwin Drive, Horsham, W. Sussex RH12 1NL (Mail order only).

(2653)

"**DIGITAL DESIGN.** We take your digital system concept from feasability study through design and development utilising the latest Mentor Graphics CAE workstation. Also semicustom digital IC design undertaken, supported by one of the worlds most experienced semicustom manufacturers. MAPCON consultancy also available. Call Gary Stangroom, Design Manager of Logic Solutions on Basingstoke (0256) 54017." (2655)

Telecommunications Maintenance Staff

for the New Mercury Network up to £13,500 + allowances

Mercury is creating a digital network based on the most up-to-date techniques. We will be supporting our service with a maintenance organisation capable of responding quickly and effectively to our customers' requirements.

As part of our expansion we require Maintenance Staff at our London, Manchester and Bristol service centres. We also need, Maintenance Engineers for our satellite earth stations in the London Docklands – standard B and in Oxford – standard C.

Field Maintenance Engineers

London, Manchester, Bristol

£10,000 – £13,500 + car + allowances

Qualified to ONC, City & Guilds or TEC level in telecoms, you must have a detailed knowledge of digital and analogue techniques applied in this field. At least three years experience of maintenance and repair to component level in the following areas is essential:-

- ★ Microwave point to point links
- ★ PCM/TDM multiplex systems
- ★ Digital communications systems

Ref: MTEO 8

Earth Station Maintenance Engineers

London, Oxford

£10,000 – £13,500 + £2,003 shift allowance

You must have experience of maintaining telecommunications equipment and ideally have worked on standard B or standard C earth stations. Shift work will be necessary.

Ref: ESMO 1 – quote either London or Oxford

Maintenance Support Engineers

London, Bristol £7,500–£10,500

You must have experience of maintaining and installing microwave or digital telecommunications equipment, be committed and prepared to progress to the role of Maintenance Engineer.

Ref: MSSO 1 – quote either London or Bristol

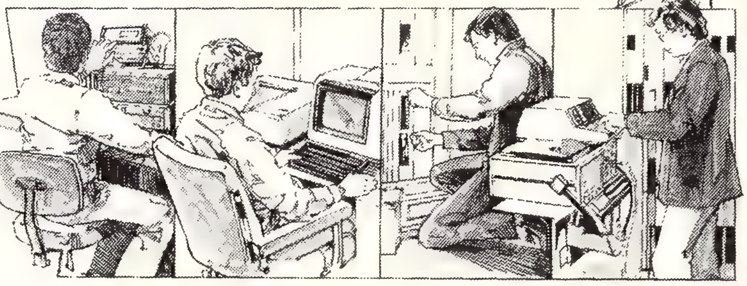
Salaries will be on the scales quoted. The exact point will depend on the experience and qualifications of the successful applicants. Benefits include non-contributory pension and a generous meals allowance. Relocation expenses will be paid, where appropriate.

Applicants for Bristol and Oxford will be required to work in London for a short period to familiarise themselves with company systems and maintenance procedures, prior to taking up their posts. The company will meet lodging expenses. London positions qualify for a £1,266 London Allowance.

Please telephone or write for an application form, quoting the appropriate reference, to

Jeremy Webster,
Mercury Communications Ltd.,
28/30 Theobalds Road,
LONDON WC1X 8NC.
Tel: 01-404 5155, ext. 242.

Mercury
COMMUNICATIONS



ELECTRONIC TEST ENGINEERS — TELEVISION STUDIO PRODUCTS

Experienced Engineers are required for test and quality assurance duties on our current range of broadcasting equipment. You would be involved in fault-finding, testing and checking to spec., sophisticated studio products, including our new range of microprocessor based colour cameras and digital test equipment.

Preferably qualified to at least HND/Higher TEC/Degree level you should be familiar with modern digital and analogue circuitry. At least three years' experience in a related field would be an advantage for the present level of vacancies.

DESIGN AND DEVELOPMENT ENGINEERS

Experienced Engineers are required for the design of TV Studio Products using the very latest analogue techniques. You will have the opportunity to see your designs made in volume production and fulfilling the high technology requirements of the '80's.

We are looking for engineers minimum age 25, who are qualified to Degree level and who have at least 3 years experience of electronic equipment preferably in television.

Salaries offered are competitive and are backed by free life and health insurance plus a contributory Pension Scheme and generous holidays. Assistance with relocation with be given where appropriate to help successful candidates move to this pleasant rural part of Hampshire, which offers easy access to London and major towns in the South of England.

Please phone JEAN SMITH on Andover (0264) 61345 for an application form or, alternatively, let us have full details of your background and experience.

(2646)

Field Service Engineer

Pro-Audio's foremost group of companies is looking for an experienced Field Service Engineer, with a working knowledge of all aspects of multitrack recorders, mixing consoles and audio equipment.

A background knowledge of Microprocessors is also required.

Candidates should be of H.N.D or Degree standard.

Salary from £10,000 - £13,000 + Car

Please apply in total confidence to:
Mike Paige, Technical Services Manager.

Bench Engineer

(2 vacancies)

Two Vacancies have arisen within our expanding Service Department. Candidates should have a working knowledge of both sound mixing consoles and multitrack tape recorders.

Although qualifications are not considered essential for these positions, experience and knowledge is.

Salary £6,000 - £7,500

Please apply in total confidence to:
Mike Paige, Technical Services Manager.

turnkey

Brent View Road, London NW9 7EL
Telephone: 01-202 4366 Telex 25769

ADVANCED AVIONICS DESIGN HEAD UP/HEAD DOWN COLOUR DISPLAY SYSTEMS

to £13,000 pa **WEST COUNTRY**

At one of the world's most advanced centres for Avionics, the Design and Development of colour display systems is contributing to the market leadership and increased profits of this major British Company.

Innovative Digital and Analogue Engineers, with at least 4 years post degree design experience, are now required to join project teams developing colour displays, interactive videos, graphics, etc. for civil and military aircraft.

For the digital positions, excellent microprocessor design experience (preferably INTEL) is essential and a background in an Avionics/Aerospace/Military environment strongly preferred.

Analogue Engineers will have experience in general high performance analogue circuit design and analysis, preferably including video amplifiers, CRT displays and switched mode power supplies.

The technological challenge offered is supported by a first class benefits package and full relocation to a rural environment with easy access to all amenities.

For further details and confidential discussion, telephone **Beverley Leonard** on **0272 277195** or send your full c.v. to:

The Recruitment Partnership
3 Marsh Street Bristol BS1 1RT

(2651)

Inner London Education Authority

Learning Resources Branch, Production Division
Television and Publishing Centre
Thackeray Road, SW8

Videotape Engineer

(Main Grade 10)

Salary scale £8,778 — £9,432 plus £1,347 London Weighting Allowance

This vacancy is in the Master Control Section which has five members. Duties include videotape editing of colour programmes, the production of tape submasters and videocassettes, plus first line maintenance of the equipment involved (CR1R formats A and C).

Applicants will be expected to have good operational experience, with a thorough understanding of the technical features, appropriate technical qualifications and a general grounding in colour television theory.

Further details together with a full job description and application forms from EO/Estab 1B, The County Hall, Room 365, London SE1. (please enclose S.A.E.). The closing date for completed application forms is the ***17th August 1984.***

This post is suitable for Job-share.

ILEA IS AN EQUAL OPPORTUNITIES EMPLOYER.

(2644)

ELECTROSONIC

SYSTEMS ENGINEER/ MANAGER

£8K — £12K + Car

The Systems Engineering Division of ELECTROSONIC wish to recruit an experienced Project Engineer/Manager to be responsible for a wide range of projects both in the UK and Overseas.

The Company, which has extensive manufacturing facilities, produces a wide range of lighting, audio and audio visual products and is a world leader in its field.

The Systems Division is responsible for the design and production of special projects which include industrial and commercial dimming, TV and Theatrical lighting, hotel and conference low voltage systems, audio and audio visual systems, including video.

The ideal candidate will be qualified to HTC/HND/Degree level or equivalent and will have experience in one or more of the above fields; but of equal importance will be his/her practical design and manufacturing experience, together with drive and ability to take a project from the drawing board to final commissioning on site. A vacancy may also exist for a Junior Engineer who is able to demonstrate the above potential.

The salary offered will depend upon experience, but will be in the range of £7,000 to £12,000 p.a. A company car is offered and other fringe benfits will include an overseas allowance.

Applicants should telephone or write to:

R.D. GORTON
Divisional Manager — Systems Engineering
Electrosonic Ltd, 815 Woolwich Road
London SE7 8LT. Telephone: 01-855 1101

(2642)

Department of Physics,
Royal Devon & Exeter Hospital
(Wonford), Barrack Road, Exeter, EX2 5DW.

Senior Physicist/ Electronics Engineer

Applications are invited from suitably qualified and experienced graduates for the post of Senior Physicist/Electronics Engineer in the Physics Department. The Physics Department provides a "radiation" physics service to three Health Authorities (Exeter, Torbay and North Devon) and is primarily involved in the fields of Radiotherapy, Diagnostic X-ray and Ultrasound, Nuclear Medicine and Scientific computing. The successful applicant will be responsible for the electronics section of the Department which is involved with both equipment maintenance and development.

Salary scale: £9010—£11649 per annum in six annual increments.

For further details of the post contact Dr C S Bowring (Principal Physicist) on Exeter (0392) 77833 ext 2262.

Exeter health Authority

Application forms and job descriptions are available from Assistant Administer ext 2007.

Closing date 17 August 1984.

(2645)

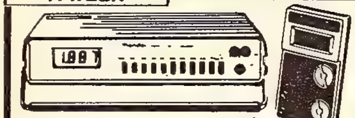
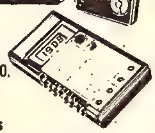
HENRY'S AUDIO ELECTRONICS

OPEN 6 DAYS A WEEK

TEST EQUIPMENT · COMPONENTS · COMMUNICATIONS · COMPUTERS

ALL MODELS ON DISPLAY

ALL PRICES EXCLUDE VAT

DIGITAL MULTIMETERS

(UK C/P & ins Bench type £1.00, Hand held 65p)

PROFESSIONAL SERIES

Thandar Bench Portables

TM355★ 3½ digit LED 29 ranges 10A AC/DC 20 Meg ohm – 0.25% basic	£85.00
TM356★ 3½ digit LCD 27 ranges 10A AC/DC 20 Meg ohm – 0.25% basic	£95.00
TM351★ 4½ digit LCD 29 ranges 10A AC/DC 20 Meg ohm – 0.1% basic	£115.00

(★Optional carry case £5.95)

Thurlby Bench Portables

(★Optional carry case £18.00)

1503★ 4¾ digit LCD 0.05% basic 10uA resolution plus frequency measurement up to 4MHZ AC/DC 10 Amps	£159.00
1503Ha★ 4¾ digit LCD as above but 0.03% basic	£175.00
1054★ 4¾ digit LCD True RMS version	£185.00
1905a 5½ digit intelligent multimeter 1uA resolution 0.015% basic	£325.00

METRIX HAND/BENCH PORTABLES (ITT)

(Size 188 x 86 x 50mm Rotary controls)

MX522 3½ digit LCD 21 ranges 10A AC/DC 2 Meg ohm Basic 0.5%	£67.00
MX562 3½ digit LCD 29 ranges 10A AC/DC 20 Meg ohm Basic 0.2% Plus continuity tester	£95.00
MX563 True RMS 3½ digit, 30 ranges 10A AC/DC, 20 Meg ohm, 20HZ to 30KHZ 0.1% basic	£155.00
MX575 4½ digit True RMS, 21 ranges 10A AC/DC, up to 50KHZ, 0.05% basic	£175.00

HAND HELD MODELS

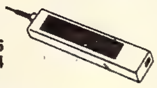
Controls: S = Slide R = Rotary PB = Push button

All feature AC/DC volts, DC amps (many with AC amps) ohms etc. (UK C/P 65p)

ALL MODELS WITH CARRY CASE

KD25C 12 range 0.2A DC 2 Meg ohm (S)	£24.43
KD305 14 range 10A DC 2 Meg ohm (S)	£24.30
KD30C 26 range 1A AC/DC 20 Meg ohm (R)	£29.13
METEX 3000 30 range 10A AC/DC 20 Meg ohm (R)	£33.00
6010 28 range 10A AC/DC 20 Meg ohm (PB)	£33.00
KD55C 28 range 10A AC/DC 20 Meg ohm (R)	£34.74
KD615 18 range 10A DC 2 Meg ohm plus Hfe tester (R)	£34.74
7030 As 6010 but 0.1% basic (PB)	£41.30
DM3350 Autorange plus cont. tester 18 range 10A AC/DC 2 Meg ohm (R)	£43.44
DM2350 Mini autorange plus cont. tester 19 range 10A AC/DC (20A Max) 2 Meg ohm (PB)	£54.73
3100 Pen type auto ranging AC/DC V 20 Meg ohm + buzzer	£39.00

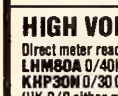
LOGIC PROBES



TTL, DTL etc.

LP10 10MHZ	£19.96
DLP50 50MHZ	£43.44

(UK C/P either model 65p)



ANALOGUE MULTIMETERS

Metrix (ITT)

Professional range

(UK C/P 65p) Size 110 x 45 x 185mm

MX130 25 ranges 5000 ohms per volt 7 DC V 0.1 to 1000, 5 AC V 10V to 1000, 6 DC Amps 100uA to 30A, 5 AC Amps 3uA to 30A 2 ohms 1K to 10K	£65.00
MX230 29 ranges 20K/Volt 100mV to 1000 V DC, 3V to 1000V AC 50uA to 10A DC, 3uA to 10A AC 1K to 10 Meg ohm	£59.00
MX430 32 ranges 40K/Volt DC 4K/V AC 10mV to 1500V DC, 5V to 1500V AC 25uA to 15A DC, 1½uA to 15A AC 50 ohm and 500 ohm (linear scale) 2000K ohm and 20 Meg ohm	£89.00

HIGH VOLTAGE METERS

Direct meter reading

LHM80A 0/40KV	£22.00
KHP30N 0/30 0/45KV	£34.74

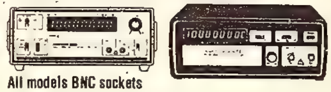
(UK C/P either model £1.00)

AC CLAMPMETER

0/300A, 0/600V AC 0/1K ohm

Total 9 ranges with carry case and leads ST300 **£26.04** (UK C/P 65p)

FREQUENCY COUNTERS



All models BNC sockets

Bench portables (UK C/P £1.00)

(PFM200A pocket counter (C/P 65p)

METEOR SERIES

UK made, 0.1HZ resolution, 8 digit, LED display, mains operated 220/240V AC, switchable gate times.

MET1000 2 range 5HZ to 100MHZ (120MHZ typical)	£89.00
MET600 3 range 5HZ TO 600MHZ (700MHZ typical)	£115.00
MET1000 3 range 5HZ to 1GHZ (1.2GHZ typical)	£159.00

(Optional 6 x nicads £9.95)

SABTRONICS

New models, LED display, switchable gate times.

8110A 8 digit 20HZ to 100MHZ	£79.00
8610B 9 digit 10HZ to 600MHZ	£109.00
8000B 9 digit 10HZ to 1GHZ	£149.00
8500B 9 digit up to 1½GHZ	£239.00

THANDAR

UK made LCD displays with batteries.

TF040 8 digit 10HZ to 40MHZ LCD, 1HZ resolution 40mV sensitivity, 2 gate times with batteries	£120.00
TF200 8 digit 200MHZ LCD, 2 ranges resolution 1ppm, 10mV RHS sensitivity, 5 gate times with batteries	£165.00

Optional carry case £5.95, AC mains adaptor £6.95.

PFm200A Pocket 8 digit 20HZ to 200MHZ, 2 band LED display with battery 0.1HZ resolution, 10mV sensitivity with battery	£69.50

PRESCALERS

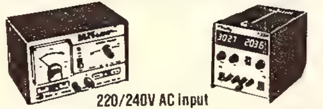
Suitable for most types of counters to extend range. (Thandar) BNC sockets.

TP600 40MHZ to 600MHZ, 10mV RMS, direct powered by counter	£45.00
TP1000 100 to 1000MHZ complete with AC adaptor P/S, 25mV RMS sensitivity	£65.00

Optional probe kits – suitable for all models

X1 **£6.90** X10 **£8.26**

VARIABLE POWER SUPPLIES



220/240V AC input

PP241 single meter, A/V switch, 0/30V 1 amp	£30.43
PP243 3 amp version	£52.13
230N Twin meter 0/30V 1A	£91.00
330N 3 amp version	£164.00

(UK C/P above models £1.00)

PL Laboratory series · LED readout · QMD versions series/parallel etc.

PL310 30V 1A	£118.00	**PL310** QMD	£249.00
PL320 30V 2A	£145.00	**PL320** QMD	£315.00

(UK C/P above models £2.50)

ANALOGUE MULTIMETERS

General range (★mirror scale)

(UK C/P 65p)

HC6015 15 range pocket 10K/Volt 1 meg ohm	£7.39
M200 30 range 20K/Volt 20KHZ Special purchase **£8.65** (list price £19.00)	
HM102BZ★ 22 range 20K/Volt 10A DC plus cont. Buzzer, 10 Meg ohm	£11.74
TMK500★ 23 range bench, 30K/Volt 12A DC Plus cont. buzzer, 20 Meg ohm	£20.83
NH56R★ 22 range 10K/Volt, 6 Meg ohm	£10.39
830A★ 26 range 30K/Volt 10AC/DC: 10 Meg ohm	£20.83
360TR★ 23 range bench, 100K/Volt, large scale, 10A AC/DC plus Hfe tester, 10 Meg ohm	£34.74
AT2100★ 31 range de luxe 100K/Volt 10A AC/DC: 100 Meg ohm	£29.13
AT1020★ 18 range de luxe 20K/Volt plus Hfe tester, 5 Meg ohm	£18.26
YN360TR★ 19 range 20K/Volt plus Hfe tester 1 Meg ohm	£12.13
KRT5001★ Range doubler 35 range total 50K/Volt 10A DC 20 Meg ohm	£17.35
ST303TR★ 22 range 20K/Volt plus Hfe tester 12A DC 1 Meg ohm	£15.61

ELECTRONIC INSULATION TESTER

500V/0-100 Meg ohm with carry case, leads etc.

YF501 **£59.13** (UK C/P 65p)

SIGNAL GENERATORS

220/240V AC (UK C/P & ins £1.00)

Bench portable all sine/square/triangle/TTL/etc. External sweep mode.

FUNCTION

Thandar TG101★ 0-.02HZ to 200KHZ various facilities	£105.00
Thandar TG102★ 0.2HZ to 2MHZ various facilities	£155.00
Jupiter 500 0.1 Hz – 500 KHZ	£110.00
Thandar Pulse Bench portable **TG105**★ 5HZ to 5MHZ Various facilities	£105.00
★ Optional carry case	£5.95

AUDIO

Leader LAG27 5 band sine/square O/P 0/5V RMS Dist 0.05% 10HZ to 1MHZ	£93.00
Leader LAG120A 5 band 10HZ to 1MHZ to 0-3V RMS into 600 ohm 0.05% dist, sine/square	£145.00
Leader LAG125 5 band 10HZ to 1MHZ to 0-3V RMS into 600 ohm sine/square/burst signals 0.03% dist	£330.00
TRIO AG202A 4 band 20HZ to 200KHZ, 10V RMS O/P 0.5% dist. CR OSC 0/10V pp O/P	£89.00
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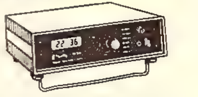
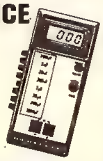

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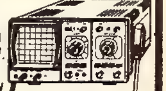
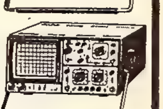

HM103 Single trace, 10MHZ, 2mV, 6 x 7cm display plus component tester	£158.00
HM203 Dual trace 20MHZ 2mV. Algebraic add, 'Z' Mod, plus component tester (Optional carry case £21.50)	£264.00
HM204 Dual trace 20MHZ, sweep delay, 2mV, plus component tester (optional carry case £21.50)	£365.00
HM605 Dual trace 60MHZ, delay line, 1mV, 1MHZ CALGEN (optional carry case £21.50)	£487.00

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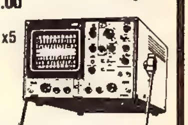

All models 5mV (1mV using x5 magnifier)

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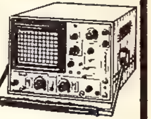

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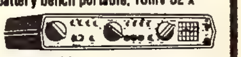

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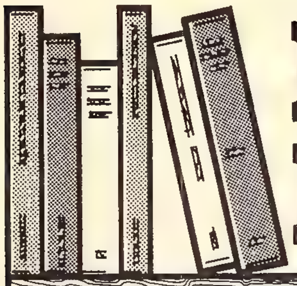

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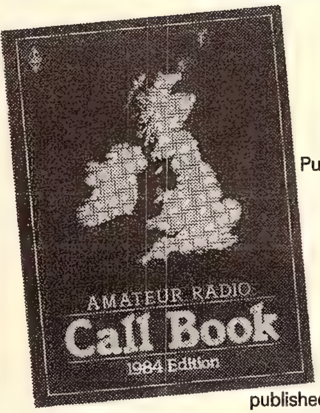

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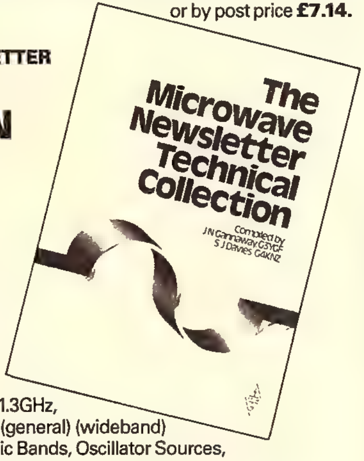

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ELECTRONICS & WIRELESS WORLD

EDITORIAL FEATURES 1984

ISSUE DATE	PUBLICATION DATE	FEATURE
Sep. 1984	Aug. 15th	Digital Multi-meters
Dec. 1984	Nov. 21st	Components Buyers Guide
Jan. 1985	Dec. 19th	Single Board Computers
Mar. 1985	Feb. 16th	IEEE Instruments
May. 1985	April. 19th	Power Supplies
July. 1985	June. 21st	VDU's
Sept. 1985	Aug. 16th	Communication Receivers

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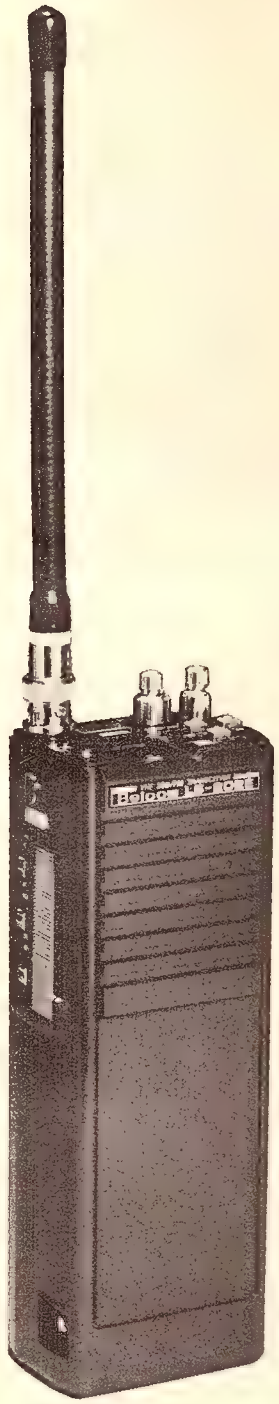
Two-metre transceivers

A survey of amateur radio equipment for the popular 144-146MHz band



For most newly-licensed radio amateurs, the two-metre band is a natural starting point. It is the lowest band available to those without proficiency in morse code. It is also the most populous: there are no worries about finding other stations to talk to.

Most equipment now in use on 2m is factory-built, almost invariably in the Far East; and a wide choice is available with prices starting at a little over £100. But it is still possible for the constructor to get on the air with a home-built rig at a cost of perhaps a few tens of pounds*.

The average newcomer's choice is likely to be a narrow-band f.m. set, for use mainly in the channelized region above 145MHz. This type of rig closely resembles the sort of c.b. set from which many new licensees have recently graduated: the controls are few and simple, and operation involves little more than pushing the button and talking.

For this reason, experienced operators often prefer single-sideband operation, where the technical demands are greater and the rewards higher. With weak signals, s.s.b. has a considerable advantage over f.m. and is essential for serious long-distance working.

Nevertheless, many old hands do use f.m. A chat on two metres, possibly through the local repeater, can be a pleasant enough way of whiling away the traffic jams on the way to work.

A type of set which has grown rapidly in popularity in recent times is the hand-held portable transceiver. Small enough to fit into the pocket, it can be taken anywhere; and for those with something grander at home, it makes a convenient second rig. The latest models offer performance figures and features scarcely inferior to those of larger units. Most hand-helds offer f.m. only, though there is at present one s.s.b. model.

The third main transceiver type is the basestation. This is typically quite a large and complex unit, normally mains-powered but often with a d.c. supply option for use with a car battery. Most ready-built basestation units are multi-mode sets, providing all three of the common amateur radio transmission modes: narrow-band f.m., s.s.b. and (for morse code) c.w. Amplitude modulation is more or less dead on v.h.f., despite one or two attempts to revive it: the few stations still using a.m. are equipped mostly with second-hand commercial radiotelephones.

The multi-mode set also makes a useful building block for forays into the higher bands by providing a stable frequency source for multiplying up through devices such as varactor triplers.

Technical features

Commercial amateur radio equipment has changed considerably during the last few years. Perhaps the most conspicuous development, in v.h.f. transceivers at least, is that digital frequency synthesizers have almost entirely displaced switched crystal oscillators and free-running variable frequency oscillators.

True continuous tuning has become virtually a thing of the past in 2m equipment. Most sets tune in steps governed in the first instance by the frequency of the synthesizer's v.c.o. With f.m. equipment for the European market, the step size is often 12.5 or 25kHz. This gives easy tuning of the numbered f.m. channels on 2m, which are spaced 25kHz apart. So an f.m.-only set which scans in smaller steps may be awkward to handle when rapid retuning is called for. However, in many synthesized sets the channel spacing can be programmed by the user.

On s.s.b., tuning steps as small as 100Hz are the norm. But s.s.b. sets also have a clarifier or receiver incremental tuning control (r.i.t.), which allows the receive frequency to be offset slightly from the transmit frequency: this is to help resolve off-channel transmissions. On the more expensive multi-mode sets there may also be a control to pull the transmitter frequency slightly, for satellite working. With this, the operator can compensator for Doppler shift as the spacecraft approaches and recedes.

In some of the cheapest sets, the hand-held portables, frequency selection is by means of a bank of thumbwheel switches. This method works well enough if the switches are reliable, though some users may prefer to pay a bit more to have a digital display giving positive indication of the tuned frequency. Many recent portables have a low-power liquid crystal display, with a calculator-

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REV
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M.CH
PR.W
M
TRIO
DWN

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*For a more complex transceiver suitable for home construction, see T.D. Forrester's design in *Wireless World*, November 1982 to April 1983, with a postscript in August 1983.

Model	Price (£)	Style	Tx modes	Other bands	Tx power	Syn/ xtal	F.m. step	Tuning method	Mem-ories	Scan mode	Dis-play	S-meter	Rx sensitivity	Audio out	Power needs	Battery capacity	Size (mm)	Weight (kg)	Features	Optional extras
WPO 2m Talkbox	68	kit	f	-	1W	X	-	-	6 ch	-	-	-	0·25μV,10dB	-	12V	-	-	-	Rx and tx available separately	Synthesized v.f.o., £38.50
Wood & Douglas	74	kit	f	-	10W	X	-	-	-	-	-	-	0·4μV,12dB	<1·5W	12V	-	-	-	Modular kit system	Synthesized version, £100; many add-ons
Belcom LS-20XE	139	hand	f	-	1>0·1W	S	5kHz	thumbw	-	-	-	-	1mV,>26dB	>0·1W	6V,20<500mA	4 x AAA	140x69x26	0·28	Very compact	Headset, NiCd cells, charger
FDK Palmcomm II	139	hand	f	-	>1·5W	X	-	knob	6 ch	-	-	-	-4dBμV,20dB	0·5W	12V,25<300mA	225mAh	68x154x41·5	0·47	Capacitor mic	Throat mic, headset, speaker-mic
Standard C110	140	hand	f	-	2·5/0·15	S	5kHz	thumbw	-	-	-	mc	0·2μV,12dB	0·3W	9V,20<750mA	450mAh	176x65x34	0·47	2.5W output is with optional NiCd pack	Choice of chargers
Yaesu FT203R	169	hand	f	-	2·5W	S	5/10kHz	thumbw	-	-	-	mc	0·25μV,12dB	0·45W	<13V,<0·7A	425mAh	65x34x153	0·45	Draws 20mA on standby	Headset for vox operation; bigger NiCd pack
Icom IC-2E	173	hand	f	-	1·5/0·15	S	5/10kHz	thumbw	-	-	-	-	<0·4μV,20dB	>0·3W	8V,20<550mA	250mAh	165x65x35	0·45	Very compact	Interchangeable NiCd packs in three sizes
Yaesu FT208R	179	hand	f	-	2·5>0·3W	S	5/10kHz	keypad	10	b,m	lcd	-	0·4μV,12dB	0·5W	10·8V,<0·5A		168x61x49	0·72	20mA standby current	Chargers, car adaptor, power amplifier
NDi HC-1400	179	mobi	f	-	25W	S	5	d	3	-	led	mc	<0·3μV,12dB	2W	13·8V,<5A	-	182x66x258	3·4		
Standard C8900	219	mobi	f	-	10W	S	5/25kHz	d,u-d	5	b,m	led	bar	0·15μV,12dB	2W	12V,0·4<2·8A	-	138x31x178	1·1	GaAs fet r.f. amp; tiltable display	-
Belcom LS-202E	225	hand	f,s	-	2·5/0·5	S	5kHz	thumbw	-	-	-	mc	0·25μV,10dB	>0·4W	9V,30<750mA	6 x AA	165x62x40	0·5	Dual mode; >3.5W output with 12V supply	Console for mobile use; can accept 25W linear amp.
Icom IC-02E	239	hand	f	-	3>0·5W	S	12·5/25k	keypad	10	m	lcd	bar	<0·32μV,20dB	>0·5W	8V,45mA<1A	250mAh	165x65x35	0·515	13.8V supply gives 5W r.f. output	Interchangeable NiCd packs
KDK FM-2033	239	mobi	f	-	25/5W	S	5/12·5k	d,u-d	11	b,m	lcd	bar	0·2μV,12dB	>2W	13·8V,0·3<6A	-	162x55x182	1·7	Receiver has 1kHz r.i.t. steps	
FDK Multi-725X	239	mobi	f	-	25>1W	S	5/12·5k	d,u-d	-	b	fluor	bar	-4dBμV,20dB	>1W	13·8V,<6·5A	-	162x62x260	2·3	Two v.f.os	Expander unit for 70cm
Trio TR-2500	246	hand	f	-	2·5>0·3W	S	5kHz	keypad	10	m	lcd	-	<0·2μV,12dB	>0·4W	8V,0·03<0·8A	400mAh	168x66x40	0·54	Removable NiCd pack	
Standard C58E	249	port	f,s,c	-	1W	S	>100Hz	d,u-d	5	b,m	lcd	mc	0·22μV,12dB	>1W	<16V,·09<·6A	450mAh	129x52x190·5	1·45	Separate mic	25W booster; mobile mounting bracket
Yaesu FT230R	259	mobi	f	-	25/3W	S	5/10kHz	d,u-d	10	b,m	lcd	mc	0·25μV,12dB	>1W	13·6V,0·3<5A	-	150x50x174	1·3	Two v.f.os	Speaker-mic
Yaesu FT290R	269	port	f,s,c	-	2·5	S	5/10kHz	d,u-d	10	b,m	lcd	mc	0·25μV,12dB	1W	70<800mA	8 x C	150x58x195	1·3	Two v.f.os; telescopic antenna	Speaker-mic etc.
Trio TM201A	279	mobi	f	-	25/5W	S	5kHz	d,u-d	5	b,m	led	bar	0·22μV	>2W	13·8V,<5·5A	-	141x39·5x183	1·25	GaAs fet r.f. amp, two v.f.os, separate speaker	Remote control/display unit
Icom IC-27E	319	mobi	f	-	25/5W	S	12·5/25k	d,u-d	9	b,m	led	bar	<0·4μV,20dB	>2W	13·8V,<6A	-	140x38x177	1·2	Very compact; two v.f.os	Speech synthesizer, £25
Trio TR-7930	323	mobi	f	-	25/5W	S	5kHz	kpad,u-d	21	b,m	lcd	bar	<0·25μV,12dB	>2W	13·8V,<6·5A	-	175x64x206	1·8		
FDK Multi-750XX	349	mobi	f,s,c	-	20/1W	S	100Hz/5k	d,u-d	-	b	fluor	bar	-4dBμV,20dB	1·3W	13·8V,<5A	-	162x62x260	2·3	Two v.f.os	Expander unit for 70cm
Icom IC-25H	359	mobi	f	-	45/2W	S	5/15/25k	d	5	b,m	led	bar	<0·6μV,20dB	>2W	13·8V,<9·5A	-	140x50x222	1·9	High-power version of old IC25E; two v.f.os	Memory back-up for mobiles
Standard C5800E	359	mobi	f,s,c	-	25/1W	S	>100Hz	d,u-d	10	b,m	led	bar	0·19μV,12dB	>2W	12V,·45<4·7A	-	149x55x218	1·9		Speaker-mic
Yaesu FT480R	399	mobi	f,s,c	-	15W	S	>1kHz	d,u-d	4	b,m	fluor	bar	0·35μV,20dB	2W	13·8V,0·5<3A	-	180x60x240	2·9	Dual v.f.os	Tone encoder, p.s.u., station console
Trio TR-9130	458	mobi	f,s,c	-	25/5W	S	12·5/25k	d,u-d	6	b,m	led	mc	<0·25μV,12dB	>2W	13·8V,<5·5A	-	170x68x241	2·4	Two v.f.os	
Trio TW-4000A	488	mobi	f	70cm	25/5W	S	5/25kHz	d,u-d	10	b,m	lcd	bar	<0·17μV,12dB	>2W	13·8V,<7·5A	-	161x60x217	2·0	GaAs fet preamps, two v.f.os	Voice synthesizer (£25) fits internally
Icom IC-290D	499	mobi	f,s,c	-	25/1W	S	1/5kHz	d	5	b,m	led	bar	<0·6μV,20dB	>2W	13·8V,<6A	-	170x64x218	2·5	Two v.f.os	NiCd battery for memory retention
Icom IC-271E	649	base	f,s,c	-	25>1W	S	1/5kHz	d,u-d	32	b,m	fluor	mc	<0·3μV,12dB	>2W	13·8V,<6A	-	285x110x275	5·2	For mains use, requires internal s.m.p.s., £149	Computer interface, voice synthesizer
Yaesu FT726R	739	base	f,s,c	-	10W out	S	20/200Hz	d,u-d	11	b,m	fluor	mc	<0·25μV,12dB	>1·5W	ac/12V,<4·5A	-	334x129x315	11	Duplex mode with optional satellite i.f. unit	R.f. modules for 6m, 70cm and (to come) h.f.
Icom IC-271HE	789	base	f,s,c	-	100>10W	S	1/5kHz	d,u-d	32	b,m	fluor	mc	<0·3μV,12dB	2W	13·8V,<18A	-	111x286x324		For mains use, requires internal s.m.p.s., £149	Computer interface, voice synthesizer
Trio TS-780	850	base	f,s,c	70cm	10>1W	S	5/12·5k	d	10	b,m	fluor	mc	<0·2μV,12dB	>2W	13·8V,<5A	-	290x124x322	10·1	Cross-band operation; two vfos; switchable rx b.w.	

style keypad for rapid frequency selection. The display may incorporate extra features such as a bar-graph meter to indicate transmitted power and received signal strength. In mains-powered sets, or mobile equipment designed to run from a car battery, a fluorescent display is sometimes fitted: this may give better readibility under unfavourable lighting conditions.

The transmitter

The maximum power level permitted to British amateurs on the 2m band (other than those with special dispensation from the icensing authority) is a carrier power supplied to the aerial of 20dBW, or in the s.s.b. mode a peak envelope power (p.e.p.) of 26dBW. These figures correspond to 100W and 400W respectively.

The power output of the average 2m mobile f.m. transceiver is n the region of 10W. Since this ype of set is probably the most common, there is little point choosing something more powerful unless the performance of its receiver is better than average. There is no virtue in being able to shout at other stations if their replies are going to be lost in noise.

With portable and hand-held ransceivers, transmit power is usually restricted to a watt or two for reasons of battery life; but often the power can be switched o a still lower level for contacts under good signal conditions, with a dramatic reduction in battery drain. Under typical conditions, with one-minute transmission periods alternating with hree minutes of listening, the life expectancy of a battery pack is ikely to be in the region of two and a half hours.

The current drain in the standby condition is a detail worth seeking out on the manufacturer's data sheet. Some of the early portables had led displays which were so heavy on current that they had to be blanked for much of the time. But if the user anticipates long periods of intensive operation, it is worth looking for a model with a quick-change battery pack so that a spare can be slipped in when the output starts to droop. With certain sets, the manufacturers offer a choice of packs in different sizes, some of them having a higher-than-usual nominal voltage to give increased transmit power.

The receiver

Receivers too have their share of design improvements. Ceramic filters offer excellent filtering at low cost, and new low-noise r.f. devices are bringing enhanced performance in the front-end. Beginning to make an appearance in commercial two-metre equipment is the gallium arsenide fet. But it is worth bearing in mind that fashionable components do not automatically make a set better.

Receiver sensitivity usually features prominently in radio manufacturers' promotional material, though the figures quoted are not always expressed in the same units and it can be difficult to raw meaningful comparisons. However, the 'goodness' of a receiver is affected by many other factors, including resistance to overloading, resistance to out-of-band signals and the quality of the filters. The sensitivity figures should not therefore be taken on their own as an index of the receiver's overall merit.

As it is with cars, so with transceivers: even the cheapest will get you from A to B if the road is open. So what are the advantages of buying one of the more expensive models? With radios, even the costliest cannot offer extra speed. But it can provide a range of features designed to make a session at the microphone more interesting and less tiring.

Among these are extra memories for storing commonly used frequencies; additional scanning modes; accessories such as a voice synthesiser to supplement the front panel display; plug-in radio-frequency modules for other bands; an interface unit enabling the transceiver to be controlled automatically by the user's computer; and of course more transmitter power and a better receiver.

Notes on the table

Price: the distributor's UK price, including v.a.t.

Style: entry indicates whether the set is intended for portable, mobile or base-station use. However, for many mobile units it is possible to buy desk-top consoles with mains power units; and for some portables, car fixing kits are available.

Modes: 'f' indicates narrow-band f.m.; 's' indicates s.s.b.; 'c' indicates c.w.

Other bands: this survey includes one or two dual-band models. For certain other sets, r.f. modules giving coverage of additional bands are available as an accessory.

Tx power: the transmitter power quoted by the manufacturer, normally for the f.m. mode. Two figures separated by an oblique stroke indicate high and low power settings. The separator '>' indicates that the power is continuously variable between the limits shown.

Syn/xtal: 's' denotes frequency-synthesiser tuning, 'x' denotes a crystal oscillator providing only those channels for which suitable crystals have been fitted.

F.m. step: the normal minimum tuning step in n.b.f.m. use. Some multi-mode sets are capable of much smaller steps even on f.m. In many cases, the size of the step is programmable: for example, 12.5 and 25kHz can be selected instead of 5 and 10kHz if the user wishes.

Tuning method: 'd' indicates a conventional knob or dial, 'thumbw' indicates thumbwheel switches and 'u-d' indicates up-down buttons.

Memories: most present-day sets permit storage and instant selection of a number of the user's favourite frequencies. Certain models also have one or more variable-frequency oscillators which can be used as additional memories.

Scan modes: some sets allow scanning of frequencies stored in memory ('m'), others provide scanning of the entire band ('b') or programmable sectors of it.

S-meter: most sets include a received signal-strength meter of some sort. Often this doubles as a power level indicator. The entry 'bar' indicates a bar-graph indicator as distinct from a moving-coil meter, 'mc'.

Receiver sensitivity: the figure shown is, where possible, for the f.m. mode.

Power needs: some hand-held sets tolerate a wide range of supply voltages, while mobile sets work best on the 13.8v provided by a reasonably healthy car battery. Figures for current indicate the consumption on standby and while transmitting on high power.

Battery, mA-hour: storage capacity of the standard battery. Most portable sets are supplied with nickel-cadmium rechargeable batteries. Batteries of other sizes may be available as an accessory. many sets, portable and otherwise, have a smaller battery (not indicated here) for memory retention.

Amateur Electronics UK
504-516 Alum Rock Road
Birmingham 8
Tel. 021-327 1497/6313
Yaesu

Arrow Electronics Ltd
5 The Street
Hatfield Peverel
Essex
Tel. 0245-381626
NDi

Lee Electronics Ltd
400 Edgware Road
London W2
Tel. 01-723 5521
Standard

Lowe Electronics Ltd
Chesterfield Road
Matlock, Derbyshire DE4 5LE
Tel. 0629-2817/2430/4057
Trio, Belcom

Microwave Modules Ltd
Brookfield Drive
Aintree, Liverpool L9 7AN
Tel. 051-523 4011
Numerous preamplifiers, power amplifiers, converters and transverters

Modular Electronics Ltd
95 High Street
Selsey, Chichester, Sussex
Tel. 0243-602916
Preamplifiers, linear amplifiers and r.f. components

Mutek Ltd
Bradworthy
Holsworthy
Devon EX22 7TU
Tel. 0409 24 543
Preamplifiers etc.

Thanet Electronics Ltd
143 Reculver Road
Beltinge, Herne Bay
Kent CT6 6PD
Tel. 02273-63859/63850
Icom

South Midlands Communications
Rumbridge Street
Totton, Southampton SO4 4DP
Tel. 0703 867333
Yaesu, KDK

Waters and Stanton Electronics
18-20 Main Road
Hockley, Essex
Tel. 0702-206835/204965
FDK, Trio

Wood and Douglas Ltd
Unit 13, Youngs Industrial Estate
Aldermaston, Reading RG7 4PQ
Tel. 0736-5324
2m transceiver modules.

WPO Communications
20 Farnham Avenue
Hassocks
West Sussex, BN6 8NS
Transceiver kits

PREFERRED VALUES

It is not unusual for the engineer to be condemned for incompetence when his strictly practical camel fails to look like the mathematician's image of an elegant but non-existent breed of horse. Preferred values are selected not by rigid arithmetic, but as the result of some very clear and simple thinking about tolerances and their application to the real world. Since the 20% range has produced the most glaring 'anomaly', let us use it as our example.

To produce a series of figures such that any value will fall into the tolerance band of one of them, they must be related so that the top end of the lower band coincides with the lower end of the higher one. In our case this is to say that 120% of the lower should be 80% of the higher, so they should stand in the ratio of 1 : 1.5. In practice the 'Two-digit' rule will prevent this from always being met, and rounding of a calculated value will be required. This must always be in the sense to close the gap between the two values, since the other way will produce a 'hole' into which components could fall and so be lost. This consideration also leads to the conclusion that when rounding has taken place, the next value must be based on that rounded value and not the calculated one. This destroys once and for all any elegant arithmetic relation. Lastly, in order to keep the total number of values down as far as possible, it is sensible to select the 10% values from those already existing in the 5% range (if possible) and the 20% from the 10%.

We can now see where this reasoning gets us. Starting initially from the lowest value:

previous selected value ×1.5	selected value
-	1
1.5	1.5
2.25	2.2
3.3	3.3
4.75	4.7

Now the problem. On this basis the next value should be 7.0 (although it could be less) and the next is over 10 by quite a bit. Let us therefore consider what happens if we calculate back from 10. We will now have a value 6.7 (although it could be more). So there are four possible values available all of which would meet the 'no holes' criterion. 6.8 is the only one to appear in the 5% range, or in the 10% range for that matter.

Mr Scott tells my namesake that he will find the 'same standard of arithmetic' in all three ranges. Precisely so. However we have one more obstacle to overcome. Calculate the 5% range and you will get two values (1.4 and 1.7) which do not appear in the standard, transgressing the 'no-holes' rule. With them in there was a great deal of overlap, while without them the holes are only very small. The need to keep the number of values to the minimum was presumably judged to be the over-riding factor.

Even if the poor beast does have bad breath, it is still not a bad camel in a hard world!

Alan Watson
Pollense
Mallorca

GPIB COMBINER COMMENTS

I refer to the article in the April 1984 issue of *Wireless World* by D.J. Greaves., the 'GPIB combiner'.

Mr Greaves' design, though ingenious, is a complex hardware solution to a problem imposed by his coice of GPIB controller. The particular machine he employs (the CBM Pet) does not implement the full GPIB standard and lacks the ability to pass control. The concept of the design is based on a fallacy brought about by the author's reliance on a particular manufacturer's interpretation the function of a GPIB controller. Mr Greaves states 'The main disadvantage of the [GPIB] bus is that only one controller may be connected to the string of peripherals at one time.' That statement is incorrect.

The IEEE-488 Standard specifically allows for multiple bus controllers. A GPIB controller which implements the full IEEE-488 standard includes the capability to pass control to another controller connected to the same bus. Most GPIB controllers commercially available include this capability, typically as a high-level language statement. Also, several commercial l.s.i. devices are available which implement this GPIB feature. As recently as February 1984 your magazine described an interface module available for the BBC microcomputer using an l.s.i. device which includes bus control transfer.

More than one controller may have access to peripherals on a single GPIB through the existing standard using software. It is not necessary to spend time designing a hardware multiplexer for GPIB controllers. The user who finds that he needs to attach several controllers to his bus will find a neater and quicker solution by selecting his bus controllers with this capability built-in. There are several well known international manufacturers of GPIB instrumention, and several less-well-known national ones, who can supply GPIB controllers with pass-control as a standard feature.

J. Summers
Application Manager
Fairchild Camera and Instrument (UK) Ltd.

IS LIGHT VELOCITY A CONSTANT?

The questions about relativity theory will not go away; Michael M. Albahari ("Is light velocity a constant?" February letters) is mistaken if he considers that the issue could be resolved by accurate measurement of time and distance; the real conflict is between incompatible philosophical hypotheses.

The complex of notions embodied into the Special Theory of Relativity (and from which the General Theory was developed by processes of logic) is based on two propositions selected from several alternatives:

1. All inertial frames of reference are equivalent in their physical characteristics.

2. Light travels in any fixed direction with the same velocity c in all inertial reference systems.

Professor Albert Einstein stated (2) as a corollary to (1) in his 1905 paper 'Electrodynamics of Moving Bodies', but notwithstanding the validity of (1), it is impossible to give an unambiguous interpretation of (2) because velocity exists between two physical entities and is not something that reside independently within frames of reference.

Implicit in the theory as developed from (1) and (2) are two generally unstated propositions:

3. Electromagnet radiations impinge upon the surfaces of all materials conglomorates, from unoccupied space with the same velocity *c*.

4. Unoccupied space has no characteristic which regulates tl propagation of radiations crossing it, except to guide it in straight path.

To render (3) and (4) some appearance of plausibility Einstein made the suggestion that 'The relations between co-ordinates of two systems in uniform motion relative to each other cannot be indentical with those of Newtonian physics in which simultaneity is absolute'.

The problem of interpretatio of this assertion in terms of experience is the real stumbling-block for relativity theory; the late Professor Herbert Dingle strongly suggested that no meaningful interpretation is possible. Some further propositions which readers may like to comtemplate are:

5. A unique universal medium (aether) propagates radiations at the velocity *c*.

6. Material conglomerates moving through the aether of (5 suffer spatial contractions along the axis of motion in proportion to its rate and concomitantly their internal processes are retarded.

In his 1905 paper Einstein recognised the Lorentz-Fitzgerald contraction time-dilation effects as consequences of (2), the former effect being considered as 'apparent' and the latter as real, which was a blatant inconsistency.

The development of the General Theory requires the Lorentz-Fitzgerald effects to be physical; it is not generally state that this in turn produces difficulties with the dynamics-energy possessed by rotating entities, and the development of the theory to require an increase of mass with increase in velocity through the ether violates the principle of energy-mass conservation.

Some further propositions are:

7. Electromagnetic radiation emanates from every emitter with a velocity relative to that emitter and remains directly related to that emitter indefinitely (i.e. each emitter is embedded in its own individual medium).

8. All radiating media have similar characteristics, and as a corollary exist 'within' or 'throughout' each other, and have a general propagational velocity of c where remote from matter.

9. The characteristics of media in (8) may be modified in the proximity of considerable conglomerates of dense matter.

Proposition (7) was originally stated by Michael Faraday (*Phil. Mag* Vol.28, No.188, May 1846), and as misinterpreted by Clerk Maxwell to have the meaning of (5) and thus taken as providing the basis for his equations of the electromagnetic field. When (5) appeared to have been rendered untenable by some rather inept exercises in research, Einstein raised his 1905 paper in an attempt to show that we can have as many ethers as we like; he made the mistake of implying that all receivers of radiation must be embedded in their own individual ethers, this being the interpretation he gave of (2). Faraday's proposition (7) amounts to the complement of this, and avoids the complication of (2). Although (1) may be invalid if the physical universe has a centre-point about which it is in rotation, and (2) cannot be tested unless its ambiguity is resolved, (3), (5), (7), (8) and (9) can be subjected to physical investigation to varying degrees of determination.

It is doubtful that the members of professional bodies are as yet prepared to embark on such work, since it would be inexpedient to demonstrate that their uncritical commitment to relativity theory may have been mistaken.

C. B. V. Francksen
Farnborough
Hants

XY PLOTTER

I am prompted to write to you because of the very interesting XY plotter by P.N.C. Hill. I am retired now, from running a plastics injection factory, but have long been keen on electronics, photography, astronomy.

For a number of years, I have been experimenting with a method of printing colour photographs direct on to paper by scanning as in the facsimile process. This started with EF50s and multiplier cells and progressed to transistors and has involved many different models using ballpens and also carbon paper for the image. I even tried a mixture of metal indicators soaked into paper with glycerine and electrodes of copper, nickel and molybdenum to mark the paper. So far, the carbon paper has seemed the best to manage with limited funds to spend on research.

In the course of these experiments I have used various steppers including the Clo-Syn motors from Stewart. Not being good enough with logic circuits I have had to use simple chips like the 4017BE which give a decade count from simple pulsing and can be made to count lesser steps by reset from one of the outputs. The 4017 is used for 400 steps by the circuit shown in my sketch.

A useful chip is the SAA1027 which will drive a Slo-Syn motor and reverse in an easy manner, but my circuits have been mainly for unidirectional running...

I think by the way that Mr Hill is wrong to state the rotor is not a permanent magnet. You can feel the holding force if you turn this by finger and thumb and generate about 50 volts or so in one winding by running it as a dynamo. Also, I have some motors from the States, including a Rapid Syn with four coils which has a magnetic hold so strong that it is hard to turn by hand. This performs very well as it has 12 volt coils and better torque than the Slo Syn.

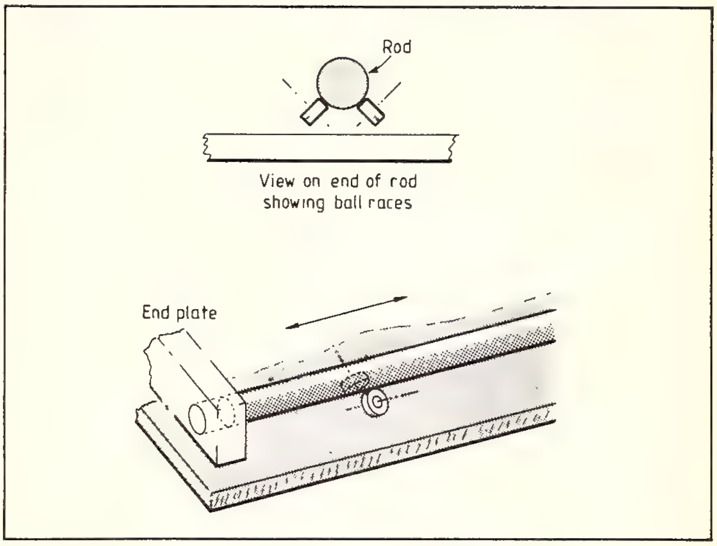
Despite this one seeming error, the article is most interesting as I have made up a plotter in the past, using ordinary motors and a potentiometer balance circuit to do transistor curve tracing. It was not very good and needed to be refined so it was scrapped.

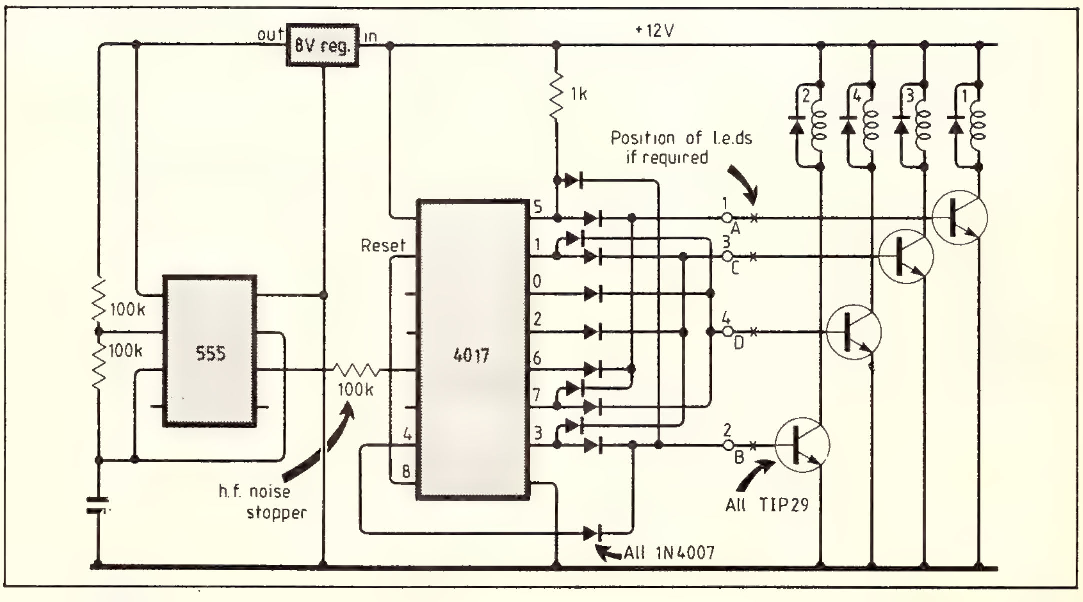
Your write-up leaves out some important details for me since it would be nice to make up a stepper plotter controlled by Basic and digital-to-analogue output from the computer with a potentiometer to compare positions.

The ball bearing idea is a good one and simple. I have used a system of crossed ball races with silver steel rods and this has proved quite good. See sketch.

A further article dealing in much more detail, with the electronics of the plotter would be welcome to me and I suspect many others.

A.J. Quinton
Thorpe Bay
Essex.





TECHNOCRATIC BONDAGE?

Your April leading article put the blame for restrictive aspects of our society on 'technocrats'. But government ministers rely on the advice from their ministers, i.e. from civil servants, and it has long been notorious that few graduates in science subjects make their way to the higher ranks of the civil service. (I guess that in addition to the fact that few of those who apply are accepted, it is probable that few apply.) So far from our troubles being due to 'technocrats', many are due to the fact that few of those in a position to influence policy have what might be called an 'engineering' outlook, a knowledge of scientific fact and method plus some appreciation of the human side of 'management'.

On the narrow issue of GCHQ I can only say that those who go to work in such an establishment should be forewarned of the burden which 'security' will place on them. From the little which I have seen from the outside, I would regard this burden of knowing things which must on no account be disclosed as the most serious factor associated with such work.

D. A. Bell
North Humberside

RELATIVITY

Much discussion concerning the Special Theory of Relativity has appeared of late both in your letter columns and in other publications, even to the extremes of scrapping the theory altogether and returning to the day of classical mechanics and the aether. On the other hand, some have raised more fruitful suggestions concerning the physical basis of the relativistic (or e—m) Doppler shift.

Surely at this stage in the career of that theory it should be evident that the theory suffers from a number of definite shortcomings: (a) it is physically incomplete, i.e., certainly questions of physics are still left open by the theory itself; and (b) as basically a correction factor to classical electrodynamics it suffers from a instrumentalist interpretation that prevents these fruitful physical questions from being asked, i.e., the theory concerns rigid rods and clocks, but does not directly have a microbasis.

Assuming that there is some validity in these observations on the theory the following questions seem to be quite open. What is the physical basis for the constancy of light's velocity if there is relative motion between source and the observer, especially since the classical physics requires that velocity to vary?

What is the physical basis for clocks (or any natural process) running slower when the inertial system of which it is a part is in relative motion?. How is the special theory related physically to quantum mechanics? Does the paradox of the twins that age at different rates depend more on relative acceleration than on relative velocity? Is the special theory valid for systems in instantaneous velocity rather than constant relative velocity? Einstein's early success (1911) in deriving the red shift formula for a gravitational field could only be explained by assuming he used relative instantaneous velocity. Finally, does the wavelength change under conditions of relative motion between a light source and observer while the velocity of the light is constant? The constancy of wave length (and associated wave number) is an unwarranted carryover from classical physics, and even Einstein himself showed his conservative nature is making this latter assumption.

G. Blondeau,
CANMET, Dept of Energy,
Mines & Resources,
Ottawa, Ont.,
CANADA

I am beginning to get the hang of much that you have recently printed; in spite of the titles, it has had nothing to do with relativity!

Science comprises a considerable body of facts and theories which support one another and which are widely considered to be true. This body can grow in two very different ways. We may wake up to new implications of what is already accepted — 'new', that is, in the sense that no one had got round to digging them out before — or we may add new facts which fit in to the old body and so consolidate it. That is, we may build on the old structure.

But we can also work on the foundations. Some of the theories in science are fundamental, which means that their truth cannot be inferred from other accepted facts or theories- their sole purpose is to provide explanations of other theories and facts. Science likes a fundamental theory if it is felt on balance inexplicable things outweigh the unsatisfactory aspect of introducing a new inexplicable idea, and provided that it does not lead to inferences which conflict with observations. In other words a fundamental theory has to be useful (it must survive Occam's razor) and it must be refutable by established facts.

Now the special and general theories of relativity, wave mechanics, gauge theories and so on are all fundamental in this sense. All that their advocates claim for them is that if you assume them to be true, you can explain a wider range of facts than you can if you assume them to be false. It is not a valid objection to a fundamental theory to say that it embraces a concept which clashes with your old preconceived ideas, or that it cannot be derived from something else.

Science has always had trouble getting people to modify their tenaciously held ideas: the sun revolves around the earth, action at a distance is conceptually impossible, and so on. Even today people get stuck with wrong ideas through failing to look at all the evidence; a clockmaker would say that the great property of a pendulum is that its period is constant but a church bellringer would say that the one thing which makes change ringing possible is the fact that a small change in the amplitude makes a big difference to the period!

J. G. D. Pratt.
West Horsley
Leatherhead
Surrey

You do your journal no service by continuing to publish these embarrassing articles by Dr Murray. It is true that there are serious imperfections in both Relativity and Quantum Mechanics and if Dr Murray confined himself to explaining them to your readers one could not object, even if one had doubts whether he was the man best qualified to do so. But it is really too much when, although apparently not able to offer any constructive comment himself, he jeers at those men who have, over the years, painstakingly put these theories together. Newton is supposed to have said tht he saw so far because he stood on the shoulders of giants. No such humility from Dr Murray who can apparently see nothing from an even better vantage point.

The community of theoretical scientists — Dr Murray's despised establishment — is well aware of the imperfections of fundamental theory but is far from complacent about them. On the contrary it continues to devise procedures for obviating them while at the same time looking for more fundamental changes which would remove them altogether. A consensus is beginning now to emerge on what the basis of a new theory might be. As usual in these matters the roots of the new theory go back a long way — originally to Hamilton's quaternions but more significantly to the work of Eli Cartan at the beginning of the century. Cartan showed that a geometrical space could be discribed not only by vectors and tensors but also by more elemental entities variously called half-vectors or spinors. These entities were first used in physics by Pauli and slightly later by Dirac who in 1930 constucted a relativistically covariant wave equation in which electron spin is inherent. What is now becoming apparent is that the spinor formulation may also be required to remove the difficulties of macro-theory.

Dr Murray may denounce these developments as even more counter to common sense than Minkowsky space but then common sense has never been of much help in theoretical physics. The nub of the matter is however easily explained to any reasonably competent mathematician. Spinors are a sort of complex number, distinguished from ordinary complex numbers by the fact that their law of multiplication is not in general commutative, that is, $A \times B$ is not necessarily equal to $B \times A$. In a group of spinors there is usually a sub-group whose multiplication law is commutative and whose properties palely reflect those of the full group; in the present case this sub-group is the complex numbers. What physics in general has been doing up to now is to use complex numbers when they should have been using the full group. Thus they have been in much the same situation as electrical engineers trying to make do with real numbers, knowing nothing about complex ones.

If a new theory along these lines is ever formulated and accepted it will be because it works better than the one it replaces.

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MC1358	1.58
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ML232B	2.50
MSM5807	6.75
PLL02A	5.75
SAA500A	3.50
SAA1025	7.25
SAA5010	6.35
SAS560S	1.75
SAS570S	1.75
SAS580	2.85
SL901B	4.85
SL917B	6.65
SL1310	1.80
SL1327	1.10
SL1327Q	1.10
SN76003N	1.95
SN76013N	1.95
SN76023N	1.95
SN76033N	1.95
SN76110N	0.89
SN76115N	1.25
SN76131N	1.30
SN76226DN	2.95
SN76227N	1.05
SN76533N	1.65
SN76544N	1.95
SN76570N	1.00
SN76650N	1.15
SN76660N	0.80
STK014	7.95
STK015	7.95
STK415	7.95
STK433	7.95
STK437	7.95
STK439	7.95
TA7061AP	3.95
TA7108P	1.00
TA7120P	1.65
TA7130P	1.50
TA7146	3.95
TA7176AP	2.95
TA7203	2.95
TA7204P	2.15
TA7205AP	1.15
TA7222AP	1.80
TA7227P	4.25
TA7310P	1.80
TA7313AP	2.95
TA7321P	2.25
TA7609P	3.15
TA7611AP	2.95
TAA550	0.25
TAA570	1.95
TAA621AXI	3.50
TAA661B	1.20
TAA700	1.70
TBA120B	0.95
TBA120C	1.15
TBA120T	1.05
TBA120U	1.00
TBA231	1.25
TBA395	1.50
TBA396	0.75
TBA440N	2.55
TBA480Q	1.25
TBA510	2.50
TBA510Q	2.50
TBA520	1.10
TBA520Q	1.10
TBA530	1.10
TBA530Q	1.10
TBA540	1.25
TBA540Q	1.35
TBA550Q	1.95
TBA560C	1.45
TBA560C	1.45
TBA560CQ	1.45
TBA570	1.00
TBA641A12	2.50
TBA651R	2.50
TBA720A	2.45
TBA750Q	2.65
TBA800	0.89
TBA810AS	1.65
TBA810P	1.65
TBA820M	0.75
TBA820Q	1.45
TBA890	2.50
TBA920	1.65
TBA950/2X	2.35
TBA970	2.95
TBA990	1.49
TBA1441	2.15
TCA270	1.10
TCA270SQ	1.10
TCA650	2.50
TCA800	2.95
TCA940	1.65
TDA440	2.20
TDA1001	1.95
TDA1004A	3.25
TDA1006A	2.50
TDA1010	2.15
TDA1035	2.50
TDA1037	1.95
TDA1170	1.95
TDA1190	2.15
TDA1270Q	3.95
TDA1327	1.70
TDA2002	1.95
TDA2020	2.95
TDA2030	2.80
TDA2522	1.95
TDA2523	2.95
TDA2524	1.95
TDA2530	1.95
TDA2532	1.95
TDA2540	1.25
TDA2541	2.15
TDA2560	2.15
TDA2571	2.95
TDA2581	2.25
TDA2593	2.95
TDA2600	5.50
TDA2610	2.50
TDA2611A	1.95
TDA2640	2.60
TDA2680A	2.75
TDA2690	2.45
TDA3560	5.50
UPC566H	2.95
UPC575C2	2.75
UPC1025H	1.95
UPC1028H	1.95
UPC1032H	1.50
UPC1156H	2.75
UPC1158H	0.75
UPC1167C2	1.15
UPC1181H	1.25
UPC1182H	2.95
UPC1185H	3.95
UPC1191V	1.50
UPC1350C	2.95
UPC1353C	2.45
UPC1365C	3.95
UPC2002H	1.95
555	0.35
556	0.42
723	0.50
741	0.35
747	0.50
748	0.35
7805	0.65
7808	0.60
7815	0.65

NEW BRANDCATHODE RAY TUBES

A1865/20	65.00
A44.120	25.00
AW36.11	25.00
CME822W	19.00
CME822GH	25.00
CME1428GH	45.00
CME1428W	39.00
CME1523GA	39.00
CME1523W	39.00
CME1431GH	39.00
CME1431W	39.00
CME202GH	45.00
CME2024W	45.00
CME2325W	45.00
CME3126GH	45.00
CME3128GH	45.00
CME3128W	45.00
CME3132GH	45.00
CME3155W	45.00
CRE1400	25.00
CV429	89.00
CV1450	35.00
CV1526	19.00
CV2185	15.00
CV2191	19.00
CV2193	15.00
CV2328	65.00
CV5119	85.00
CV5320	85.00
CVX389	55.00
D9-110GH	39.50
D9-120	45.00
D10-210GH	45.00
D10-210GH68B	65.00
D10-210GH72	65.00
D10-230GH	35.00
D10-230GM	35.00
D10-293GY/90	55.00
D13-27GH	49.50
D13-30GH	49.50
D13-33GM	49.00
D13-47GH/26	55.00
D13-47GH/34	55.00
D13-47GH	55.00
D13-51GH/34	85.00
D13-51GL/26	85.00
D13-51GM/26	85.00
D13-450GH/01	55.00
D13-471GH/26	55.00
D13-550GH	65.00
D13-600GM	59.00
D13-610GH	59.00
D13-610GM	59.00
D13-611GH	59.00
D13-611GM	59.00
D13-630GH	59.00
D14-120GH08	65.00
D14-121GH09	65.00
D14-150GH	75.00
D14-150GM	75.00
D14-172GH/84	59.00
D14-172GR	55.00
D14-172GV	55.00
D14-173GH	55.00
D14-173GM	53.00
D14-173GR	55.00
D14-181GH/62	65.00
D14-181GH/98	65.00
D14-181GJ	55.00
D14-181GM	53.00
D14-181GM50	59.00
D14-181W	55.00
D14-182GH	59.00
D14-182GM/98	65.00
D14-200BE	89.00
D14-200GA/50	85.00
D14-200GM	75.00
D14-210GH	75.00
D14-270GH/50	75.00
D14-310W	110.00
D14-320GH	85.00
D14-320GH/82	85.00
D14-340GH/KM	45.00
D14-340KA	45.00
D16-100GH	65.00
D16-100GH/65	69.00
D16-100GH/67	65.00
D16-100GH67A	75.00
D16-100GH/79	69.00
D16-100GH/79A	75.00
D16-100GH97	65.00
D18-130GH	65.00
D18-1300GH/70	69.00
D18-160GH	69.00
D21-10GH	65.00
D21-10GJ	69.00
D21-10LD	69.00
D21-102GH	65.00
DB7.6	35.00
DG7.32	45.00
DG13.2	45.00
DH3.91	45.00
DH7.11	95.00
DH7.91	45.00
DP7.5	35.00
DP7.6	35.00
DP7.11	45.00
DN13.78	35.00
F15.101LC	49.00
F16-101GM	55.00
F16-101LD	55.00
F21-130GR	55.00
F21-130LC	55.00
F21-131GR	79.00
F22-11LD	53.00
F31-10GM	65.00
F31-10GR	65.00
F31-10LC	65.00
F31.10LD	65.00
F31-12LC	65.00
F31-12LD	65.00
F31-13GR	65.00
F31.13LD	65.00
F31-13LG	65.00
F41-123LC	160.00
F41-141LG	160.00
F41-142LC	185.00
M7-120W	19.00
M14-100GM	45.00
M14-100KA	55.00
M14-100LC	45.00
M17-151GVR	175.00
M17-151GR	175.00
M19-100GY	55.00
M19-100W	45.00
M19-101GR	55.00
M19-103W	55.00
M23-110GH	55.00
M23-111W	55.00
M23-111GH	55.00
M23-111LD	55.00
M23-112GM	55.00
M23-112GV	55.00
M23-112GW	55.00
M23-112KA	55.00
M23-112LD	55.00
M23-112W	55.00
M24-120GM	59.00
M24-120GR	59.00
M24-120LC	59.00
M24-120WAR	59.00
M24-121GH	55.00
M24-121LC	59.00
M24-121WA	59.00
M28-11LA	49.00
M28-12GH	55.00
M28-12LC	55.00
M28-13LC	49.00
M28-13LG	49.00
M28-13GR	49.00
M28-13WA	49.00
M28-131GR	55.00
M28-132GM	55.00
M28-133GH	55.00
M31-100GH	55.00
M31-101GH	55.00
M31-182GR	55.00
M31-182GV	53.00
M31-183W	55.00
M31-184W	65.00
M31-184GH	65.00
M31-184P31	65.00
M31-185GH/VR	69.00
M31-186W	69.00
M31-190GH	55.00
M31-190GR	55.00
M31-190LA	55.00
M31-190W	59.00
M31-191GH	59.00
M31-191GR	59.00
M31-191GV	55.00
M31-191W	59.00
M31-192W	59.00
M31-195GH	59.00
M31-210GH	59.00
M31-220W	59.00
M31-270GY	65.00
M31-271P31	65.00
M31-271GW	65.00
M31-271W	65.00
M36-12W	75.00
M36-141LA	75.00
M36-141LG	75.00
M36-141W	75.00
M36-170LG	75.00
M38-100GR	65.00
M38-101GH	65.00
M38-103GR	65.00
M38-113GH	65.00
M38-120W	65.00
M38-120WA	65.00
M38-121GR	65.00
M38-121GHR	65.00
M38-121LA	65.00
M38-121WA	65.00
M38-122GH	65.00
M38-122GW	65.00
M38-140LA	65.00
M38-141LA	65.00
M38-142GR	65.00
M38-142LA	65.00
M38-340P31	65.00
M38-341GR	65.00
M38-341P31	65.00
M38-344P39	65.00
M40-120W	59.00
M43-12GM/01	65.00
M43-12LG/01	65.00
M44-120LC	65.00
M44-120GR	65.00
M47-25GR/22	65.00
M50-120GH	65.00
M50-120GR	65.00
M50-120GV	65.00
M50-120LC	65.00
M61-120LC	75.00
M61-120W	75.00
S6AB	45.00
SE4/D/P7	45.00
SE42BP31AL	55.00
SE42BP31	55.00
SE52AP31AL	55.00
SE5FP31	55.00
T937	65.00
T948N	65.00
T948H	65.00
V3191	59.00
V4150LC	55.00
V4254B	65.00
V4274GH	65.00
V4283W	65.00
V5002LD	65.00
V5004GR	59.00
V5004LD	59.00
V6001GH	65.00
V6006GH	65.00
V6007DP31	59.00
V6007GW	65.00
V6008GW	59.00
V6008W	65.00
V6034WA	59.00
V6048CLA	59.00
V6048F	65.00
V6048J	49.00
V6052GH	65.00
V6052GR	65.00
V6064BLA	65.00
V6064BP31	55.00
V6064CLA	55.00
V6069GH	55.00
V6070P31	49.00
V7016A	65.00
V7030	59.00
V7031GH	59.00
V7031/67A	59.00
V7035A	49.00
V7037GH	45.00
V8004GR	65.00
V8006GH	65.00
V8010A	65.00
1CP1	15.00
1CPB1	15.00
2BP1	9.00
3BP1	13.50
4EP1	30.00
3H/0BM	55.00
5BP1	9.00
5BHP1	30.00
5BHP1FF	30.00
5BHP31	30.00
5CP1	10.00
6EP7/S	39.00
13BP1	13.50
13BP4	17.50
17DWP4	25.00
32J/1085	69.00
88D	15.00
89B	15.00
89D	15.00
89L	15.00
1273	39.00
1564	39.00
1844	45.00
55451GM	75.00
9442E1	80.00
95447GM	75.00
95449GM	75.00
7709631	78.50

SEMICONDUCTORS

AAY12	0.25
AC126	0.45
AC127	0.20
AC128	0.28
AC128K	0.32
AC141	0.28
AC141K	0.34
AC142K	0.30
AC176	0.22
AC176K	0.31
AC187	0.25
AC187K	0.28
AC188	0.25
AC188K	0.37
AD142	0.79
AD143	0.82
AD149	0.70
AD161	0.39
AD162	0.39
AD161/2	0.90
AF106	0.50
AF114	1.95
AF121	0.60
AF124	0.65
AF125	0.35
AF126	0.32
AF127	0.40
AF139	0.40
AF178	1.95
AF239	0.42
AU107	3.50
AU106	3.25
AU110	2.00
BC107A	0.11
BC107B	0.11
BC108	0.10
BC108A	0.11
BC108B	0.12
BC109	0.10
BC109B	0.12
BC109C	0.12
BC114	0.11
BC116A	0.15
BC117	0.19
BC119	0.24
BC125	0.25
BC139	0.20
BC140	0.31
BC141	0.25
BC142	0.21
BC143	0.24
BC147	0.09
BC147B	0.09
BC148A	0.09
BC148B	0.09
BC149	0.09
BC157	0.12
BC158	0.09
BC159	0.09
BC160	0.28
BC161	0.28
BC170B	0.15
BC171	0.09
BC171A	0.10
BC171B	0.10
BC172	0.10
BC172B	0.10
BC172C	0.10
BC173B	0.10
BC174	0.09
BC174A	0.09
BC177	0.15
BC178	0.15
BC182	0.10
BC182LB	0.10
BC183	0.10
BC183L	0.09
BC184LB	0.09
BC204	0.10
BC207B	0.13
BC208B	0.13
BC212	0.09
BC212L	0.09
BC212LA	0.09
BC213	0.09
BC213L	0.09
BC214	0.09
BC214C	0.09
BC214L	0.09
BC237B	0.09
BC238	0.09
BC239	0.12
BC251A	0.12
BC252A	0.15
BC258	0.25
BC258A	0.39
BC284	0.30
BC300	0.30
BC301	0.30
BC303	0.26
BC307B	0.09
BC327	0.10
BC328	0.10
BC337	0.10
BC338	0.09
BC347A	0.13
BC461	0.35
BC478	0.20
BC527	0.20
BC547	0.10
BC548	0.10
BC549A	0.08
BC550	0.08
BC557	0.08
BC557B	0.08
BC558	0.10
BCY33A	1.60
BD115	0.30
BD116	0.60
BD124P	0.59
BD131	0.42
BD132	0.42
BD133	0.40
BD135	0.30
BD136	0.30
BD137	0.32
BD138	0.30
BD139	0.32
BDD140	0.30
BD144	1.10
BD159	0.65
BD160	1.50
BD166	0.55
BD179	0.72
BD182	0.70
BD201	0.83
BD202	0.65
BD203	0.78
BD204	0.70
BD222	0.46
BD223	0.48
BD225	0.48
BC232	0.35
BD233	0.35
BD234	0.35
BD236	0.45
BD237	0.40
BD238	0.40
BD241	0.40
BD242	0.50
BD246	0.60
BD376	0.32
BD410	0.55
BD434	0.55
BD437	0.50
BD438	0.60
BD520	0.65
BD538	0.65
BD597	0.75
BD701	1.25
BD702	1.25
BD707	0.80
BDX32	1.50
BDY57	1.65
BF115	0.35
BF119	0.65
BF127	0.24
BF154	0.12
BF158	0.22
BF160	0.27
BF167	0.24
BF173	0.22
BF177	0.38
BF178	0.26
BF179	0.34
BF180	0.29
BF181	0.29
BF182	0.29
BF183	0.29
BF184	0.28
BF185	0.28
BF194	0.11
BF195	0.11
BF196	0.11
BF197	0.11
BF198	0.16
BF199	0.14
BF200	0.40
BF241	0.15
BF245	0.30
BF256/LC	0.28
BF257	0.28
BF258	0.28
BF259	0.28
BF271	0.26
BF273	0.13
BF336	0.34
BF337	0.29
BF338	0.32
BF355	0.37
BF362	0.38
BF363	0.38
BF371	0.20
BF394	0.19
BF422	0.32
BF457	0.32
BF458	0.36
BF459	0.36
BF467	0.68
BF595	0.23
BF597	0.25
BFR39	0.23
BFR40	0.23
BFR41	0.28
BFR81	0.25
BFR88	0.30
BFR90	1.50
BFR91	1.75
BFT42	0.28
BFT43	0.28
BFW92	0.85
BFX29	0.30
BFX84	0.26
BFX85	0.32
BFX86	0.30
BFX88	0.25
BFY50	0.21
BFY51	0.21
BFY52	0.25
BFY90	0.77
BLY48	1.75
BR100	0.26
BR101	0.49
BR103	0.55
BRC4443	0.85
BT100A/02	0.75
BT106	1.49
BT116	1.20
BT119	2.35
BT120	1.65
BU105	1.22
BU108	1.69
BU124	1.25
BU125	1.25
BU126	1.60
BU204	1.55
BU205	1.30
BU208	1.39
BU208A	1.52
BU208D	1.85
BU326	1.20
BU407	1.24
BU500	2.25
BU526	1.90
BU80Y	2.25
BUY69B	1.70
MJ3000	1.98
MJE340	0.40
MJE520	0.48
MPSA13	0.29
MPSA92	0.30
MRF237	3.45
MRF450A	12.50
MRF453	17.50
MRF454	23.50
MRF475	2.50
MRF477	10.00
OC16W	2.50
OC23	1.50
OC42	0.55
OC44	0.75
OC45	0.55
OC70	0.45
OC71	0.55
OC81	0.50
R2008B	1.70
R2010B	1.70
R2322	0.58
R2323	0.66
R2540	2.48
RCA16334	0.90
RCA16335	0.80
SKE5F	1.45
TIP29	0.40
TIP29C	0.42
TIP30C	0.43
TIP31C	0.42
TIP32C	0.42
TIP33B	0.75
TIP34B	0.75
TIP41A	0.45
TIP41C	0.45
TIP42C	0.47
TIP47	0.65
TIP120	0.60
TIP125	0.65
TIP142	1.75
TIP146	2.75
TIP161	2.95
TIP2955	0.80
TIP3055	0.55
TIS91	0.20
TV106/2	1.50
2N2110	4.50
2N2219	0.28
2N2905	0.40
2N3053	0.40
2N3054	0.59
2N3055	0.52
2N3702	0.12
2N3703	0.12
2N3704	0.12
2N3075	0.12
2N3706	0.12
2M3708	0.12
2N3773	2.75
2N3792	1.35
2N4280	3.50
2N4427	1.50
2N4444	1.15
2N5294	0.42
2N5296	0.48
2N5298	0.60
2N5496	0.65
2SA715	0.60
2SC495	0.80
2SC496	0.80
2SC1096	0.80
2SC1106	2.50
2SC1172Y	2.20
2SC1173	1.15
2SC1306	1.00
2SC1307	1.50
2SC1364	0.50
2SC1449	0.80
2SC1678	1.25
2SC1909	1.45
2SC1945	2.65
2SC1953	0.95
2SC1957	0.80
2SC1969	1.95
2SC2028	1.15
2SC2029	1.95
2SC2078	1.45
2SC2091	0.85
2SC2098	2.50
2SC2166	1.95
2SC2314	0.80
2SC2371	0.36
2SD234	0.50
3N211	1.95
3SK45	0.70
3SK88	0.55

DIODES

AA119	0.08
BA115	0.13
BA145	0.16
BA148	0.17
BA154	0.06
BA156	0.15
BA157	0.30
BAX13	0.04
BAX16	0.06
BB105B	0.30
BT151	0.79
BY126	0.10
BY127	0.11
BY133	0.15
BY164	0.45
BY176	1.20
BY179	0.63
BT182	0.55
BY184	0.35
BY199	0.40
BY206	0.14
BY208-800	0.33
BY210-800	0.33
BY223	0.90
BY298-400	0.22
BY299-800	0.22
BYX10	0.20
BYX36-150R	0.20
BYX38-600R	0.60
BYX55-600	0.30
BYX71-600	1.10
BZY95C30	0.35
CS4B	4.50
CS10B	8.45
OA47	0.09
OA90	0.05
OA91	0.06
OA95	0.06
OA202	0.10
IN21DR	2.95
IN23B	2.95
IN23C	2.95
IN23ER	2.95
IN23WE	2.95
IN4001	0.04
IN4003	0.04
IN4004	0.05
IN4005	0.05
IN4007	0.06
IN4148	0.02
IN4448	0.10
IN5401	0.12
IN5402	0.14
IN5403	0.12
IN5406	0.13
IN5407	0.16
IN5408	0.16
ITT44	0.04
ITT923	0.15
ITT2002	0.10

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GRUNDIG 5010-6010, 2222.5011-6011	13.45
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ITT CVC30	8.25
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THORN 9800	22.40
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ITT CVC30	6.35
PHILIPS G8 550	6.96
RANK T20A	6.91
THORN 3000/3500	7.57
THORN 8500	5.80
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ITT CVC20 (200/400V)	1.80
PHILIPS G8 (600/300V)	2.25
PHILIPS G9 (2200/63V)	1.19
PHILIPS G11 (470/250V)	2.35

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ELC1043/06 MULLARD	8.65
U321	8.25
U322	8.25

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MIN. VERTICAL POTS	0.12
SANDARD HORIZONTAL POTS	0.12
MIN. HORIZONTAL POTS	0.12
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SLIDERS LINEAR	0.48

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100MA	8p each
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20MM ANTI SURGE FUSES

100MA — 800MA	15p each
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FREEZE IT	0.82
SOLDA MOP	0.64
SWITCH CLEANER	0.79
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AH238	39.00
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ARP34	1.25
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BS450	67.00
BS810	55.00
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CIK	19.00
C3JA	21.00
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C112G	70.00
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C1148A	115.00
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C1534	32.00
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CC3L	0.90
CL33	2.00
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DAF91	0.70
DAF96	0.65
DC70	1.75
DC90	1.20
DCX4-1000	12.00
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DET18	28.50
DET23	35.00
DET24	39.00
DET25	22.00
DET29	
DF91	0.70
DF92	0.60
DF96	0.65
DF97	1.00
DH63	1.20
DH77	0.90
DH79	0.56
DH149	2.00
DK91	0.90
DK92	1.20
DK96	2.50
DL35	2.50
DL63	1.00
DL70	2.50
DL73	2.50
DL91	1.50
DL92	0.95
DL93	1.10
DL94	2.50
DL96	2.50
DLS10	13.50
DLS16	10.00
DM70	1.95
DM160	2.75
DY51	1.50
DY86/87	0.65
DY802	0.72
E80CC	9.95
E80CF	11.00
E80F	13.50
E80L	11.50
E81CC	3.15
E81L	12.00
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E83CC	3.50
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E86C	9.50
E88C	7.95
E88CC	3.50
E90CC	7.95
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E91H	4.50
E92CC	3.95
E99F	6.99
E130L	19.95
E180CC	6.50
E182CC	9.00
E180F	6.50
E186F	8.50
E188CC	7.50
E280F	19.50
E283CC	10.00
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E810F	18.50
E1148	1.00
E1524	6.95
EA50	1.00
EA76	1.95
EA79	1.95
EABC80	0.70
EAC91	2.50
EAF42	1.20
EAF801	3.50
EB34	1.50
EB41	3.95
EB91	0.60
EBC33	2.50
EBC41	1.95
EBC81	1.50
EBC90	0.90
EBC91	0.90
EBF33	2.50
EBF80	0.65
EBF83	0.65
EBF85	0.95
EBF89	0.70
EBF93	0.95
EBL1	2.50
EBL21	2.00
EC52	0.75
EC70	1.75
EC80	9.50
EC81	7.95
EC86	1.00
EC88	1.00
EC90	1.10
EC91	5.50
EC92	1.25
EC93	1.50
EC95	7.00
EC97	1.10
EC8010	12.00
ECC32	3.50
ECC33	3.50
ECC35	3.50
ECC81	1.15
ECC82	0.55
ECC82 Philips	1.50
ECC83	0.65
ECC83 Brimar/Mullard	1.35
ECC83 Philips	1.95
ECC84	0.50
ECC85	0.60
ECC86	2.75
ECC88	0.85
ECC91	2.00
ECC180	0.72
ECC189	0.78
ECC801S	3.50
ECC803S	3.50
ECC804	0.60
ECC807	2.50
ECC2000	12.00
ECF80	0.85
ECF82	0.85
ECF86	1.70
ECF200	1.85
ECF202	1.85
ECF801	0.85
ECF804	6.00
ECF805	2.50
ECF806	10.25
ECH3	2.50
ECH4	3.00
ECH35	2.15
ECH42	1.00
ECH81	0.65
ECH83	0.78
ECH84	0.69
ECH2000	1.50
ECL80	0.60
ECL82	0.65
ECL83	2.50
ECL84	0.74
ECL85	0.69
ECL86	0.80
ECL805	0.69
EF37A	2.00
EF39	1.10
EF41	3.50
EF42	3.50
EF50	2.50
EF55	4.95
EF71	1.50
EF72	1.20
EF73	1.00
EF80	0.55
EF83	3.50
EF85	0.50
EF86	1.25
EF86 Special quality	2.50
EF89	0.85
EF91	1.50
EF92	2.15
EF93	0.95
EF94	0.95
EF95	1.00
EF97	0.90
EF98	0.90
EF183	0.65
EF184	0.65
EF730	1.80
EF731	3.50
EF732	3.50
EF800	11.00
EF805S	13.50
EF806S	14.50
EF812	0.65
EFL200	1.50
EH90	0.72
EK90	0.72
EL32	0.95
EL33	4.00
EL34	2.25
EL34 Philips	3.50
EL36	1.50
EL37	9.00
EL38	4.75
EL41	3.50
EL42	2.00
EL81	6.95
EL82	0.58
EL84	0.75
EL85	4.50
EL86	0.85
EL90	1.50
EL91	6.00
EL95	0.70
EL153	12.15
EL183E	3.50
EL18P	3.50
EL360	6.75
EL500	1.40
EL504	1.40
EL509	5.25
EL519	6.95
EL802	3.65
EL821	8.50
EL822	12.95
EM1	9.00
EM4	9.00
EM80	0.70
EM81	0.70
EM84	1.65
EM85	3.95
EM87	2.50
EN10	8.00
EN32	13.50
EN91	1.10
EN92	4.50
ESU872	25.00
EY51	0.80
EY81	1.50
EY83	1.50
EY84	5.95
EY86/87	0.50
EY88	0.55
EY91	5.50
EY500A	1.50
EY802	0.70
EZ35	0.75
EZ40	2.75
EZ41	2.75
EZ80	0.75
EZ81	0.75
EZ90	1.50
F6064	2.95
FW4/800	2.95
G1/371K	30.00
G55/1K	9.00
G180/2M	9.00
G240/2D	9.00
G400/1K	14.00
GC10B	17.50
GC10D	17.50
GC10/4B	17.50
GC10/4E	17.50
GC12/4B	17.50
GD86W	6.00
GDT120M	5.00
GE10	9.00
GN4	6.00
GN10	15.00
GR10G	4.00
GR10J	4.00
GS10C	16.50
GS10H	12.00
GS12D	12.00
GT1C	14.00
GT1C S/S	13.00
GTE175M	8.00
GTR150W	1.00
GU20	35.00
GXU1	13.50
GXU3	24.00
GXU50SS	14.50
GY501	1.20
GY802	1.00
GZ30	1.00
GZ31	1.00
GZ32	1.00
GZ33	4.50
GZ34	2.15
GZ37	4.50
HAA91	1.00
HABC80	0.90
HBC90	0.75
HBC91	0.80
HF93	0.75
HF94	1.50
HK90	1.05
HL2K	3.50
HL23DD	4.00
HL41	3.50
HL42DD	3.50
HL90	0.70
HL92	1.50
HL133/DD	3.50
HR2	4.00
HY90	1.00
HVR2	3.00
JP9-7A	60.00
K391A	95.00
K3118	85.00
KR6/3	45.00
KT8C	7.00
KT33C	3.50
KT36	2.00
KT44	4.00
KT45	4.00
KT61	4.00
KT63	2.00
KT66 OSRAM	10.50
KT66 USA	6.90
KT66 GEC	14.95
KT77 Gold Lion	9.50
KT81	7.00
KT88 USA	9.00
KT88 Gold Lion	15.95
KT67	9.00
KTW61	2.50
KTW62	2.50
KTW63	2.00
KTZ63	2.50
L63	1.50
L102/2K	6.95
L120/2K	12.00
LB7-20	95.00
LS9B	6.95
M502A	60.00
	85.00
M537A	60.00
M5143	155.00
M8079	6.00
M8082	7.50
M8083	3.25
M8091	7.50
M8096	3.00
M8098	5.50
M8099	5.00
M8100	5.50
M8136	7.00
M8137	5.50
M8161	6.50
M8162	5.50
M8163	5.50
M8190	4.50
M8195	6.50
M8196	5.50
M8204	5.50
M8223	4.50
M8224	2.00
M8225	3.50
ME1401	29.50
ME1402	29.50
ME1501	14.00
MH4	3.50
MHLD6	4.00
ML4	4.50
MS4B	5.50
MU14	1.50
N37	12.50
N78	9.85
OA2	0.85
OA2WA	1.50
OA3	2.50
OB2	0.85
OB2WA	1.25
OC2	2.50
OC3	1.50
OD3	1.70
OM4	1.00
OM5B	3.00
OM6	1.75
ORP43	2.50
ORP50	3.95
P61	2.50
P41	2.50
PABC80	0.50
PC86	0.75
PC88	0.75
PC92	3.50
PC97	1.10
PC800	1.10
PC900	1.25
PCC84	0.40
PCC85	0.54
PCC88	0.70
PCC89	0.70
PCC189	0.70
PCC805	0.70
PCC806	0.80
PCE82	0.80
PCF80	0.65
PCF82	0.60
PCF84	0.65
PCF86	1.20
PCF87	0.40
PCF200	1.80
PCF201	1.80
PCF800	0.40
PCF801	1.35
PCF802	0.60
PCF805	1.25
PCF806	1.00
PCF808	1.25
PCH200	1.50
PCL82	0.85
PCL83	2.50
PCL85	0.80
PCL86	0.85
PCL200	1.60
PCL800	0.80
PCL805	0.90
PD500	3.50
PD510	3.65
PEN4DD	2.00
PEN25	2.00
PEN40DD	2.50
PEN45	3.00
PEN45DD	3.00
PEN46	2.00
PFL200	0.95
PL21	2.50
PL36	0.95
PL38	1.50
PL81	0.72
PL81A	0.72
PL82	0.60
PL83	0.52
PL84	0.78
PL88	1.00
PL95	1.75
PL302	1.00
PL345	12.50
PL500	1.10
PL504	1.15
PL508	1.75
PL509	4.85
PL519	4.95
PL802	5.95
PL802T	3.50
PL820	2.95
PL5557	29.50
PY32	0.60
PY33	0.50
PY81	0.70
PY82	0.70
PY83	0.70
PY88	0.65
PY500A	1.95
PY800	0.79
PY801	0.79
Q113-110BA	47.50
QB3-300	30.50
QE03-10	3.50
QE08-200	145.00
QF40	65.00
QP25	1.00
QQE03-12	6.50
QQE03-20	27.00
QQE06-40	39.50
QQV02-6	16.50
QQVO3-10	5.50
QQV03-10 Mullard	9.50
QQV03-20	18.50
QQV03-20B	32.00
QQV06-40A	19.50
QQV07-50	63.50
QQZ03-20	42.50
QQZ06-40A	45.25
QS72/20	1.50
QS75/40	3.00
QS92/10	5.00
QS95/10	4.85
QS108/45	4.00
QS150/15	6.95
QS150/30	1.15
QS150/45	7.00
QS1200	3.95
QS1202	3.95
QS1203	4.15
QS1205	3.95
QS1206	1.05
QS1207	0.90
QS1208	0.90
QS1209	2.00
QS1210	1.50
QS1211	1.50
QS1212	3.20
QS1213	5.00
QS1215	2.10
QS1218	5.00
QU37	9.50
QV03-12	4.95
QV05-25	1.75
QV06-20	29.50
QV08-100	145.00
QV2-250	45.00
QY3-125	49.50
QY4-250	65.00
QY4-400	71.95
R10	4.00
R16	12.00
R17	1.50
R18	2.50
R19	2.50
R20	1.20
R1169	55.00
RG1-125	4.95
RG1-240A	14.50
RG3-250A	3.50
RG3-1250A	35.00
RK2K25	62.50
RG4-1000	10.00
RK-20A	12.00
RL16	1.50
RPL16	12.00
RPY13	2.50
RPY43	2.50
RPY82	2.50
RR3-250	15.00
RR3-1250	33.50
RS613	45.00
RS685	54.95
RS688	52.15
S6F17	5.95
S6F33	28.95
S11E12	38.00
S30/2K	12.00
S104/1K	10.00
S109/1K	15.00
S130	5.95
S130P	5.95
SC1/800	5.00
SC1/1200	5.00
SC1/2000	9.00
SD6000M	45.00
SP2	1.50
SP41	5.00
SP42	3.00
SS501	35.00
ST11	1.50
STV280/40	11.95
STV280/80	19.95
SU42	4.95
TB2.5/3000	85.00
TB2-300	45.00
TBL-2-300	275.00
TD1-100A	25.00
TD03-10D	35.00
TD03-10F	28.00
TD3-12	4.00
TP25	1.50
TSP4	7.00
TT11	1.50
TT15	34.95
TY2-125A	60.00
TY4-400	70.00
TY7-6000A	365.00
TY8--600W	365.00
TYS2/250	375.00
U18-20	2.75
U19	11.95
U24	2.00
U25	0.90
U26	0.90
U37	9.00
U41	6.95
U50	2.00
U82	3.00
U191	0.70
U192	1.00
U193	0.65
U251	1.00
U801	0.75
UABC80	0.65
UAF42	1.00
UBF80	0.60
UBC41	2.95
UBC81	1.50
UBF89	0.60
UBL21	1.75
UC92	1.20
UCC84	0.70
UCC85	0.60
UCF80	1.00
UCH21	1.20
UCH41	1.20
UCH42	1.35
UCH81	0.65
UF85	1.20
UF41	1.15
UF42	1.15
UF80	0.80
UF89	2.50
UL41	3.50
UL84	0.85
UU5	3.50
UU7	8.00
UU8	9.00
UY41	3.50
UY85	0.70
V235A/1K	250.00
V240C/2K	225.00
V241C/1K	195.00
V2464A/2K	315.00
V339	3.50
VLS631	10.95
VP4B	4.50
VP133	2.00
VR75/30	3.00
VR101	2.00
VR105/30	1.50
VR150/30	1.15
VT52	2.50
VU29	4.50
VU39	1.50
W77	5.00
W729	1.00
W739	1.50
X24	1.00
X66/X65	4.95
X76M	1.95
XC24	1.50
XC25	0.50
XFW47	1.50
XFW50	1.50
XG2-6400	35.00
XG5-500	22.50
XL1-5V	1.50
XL628FT	7.50
XNP12	2.50
XP1002	29.00
XR1-1600A	49.50
XR1-3200A	79.50
XR1-6400A	99.50
Y63	1.50
Y65	6.95
Y602	12.00
YD1100	75.00
YJ1060	265.00
YL1020	29.00
YL1070	115.00
YL1071	109.00
Z77	1.20
Z302C	12.00
Z359	9.00
Z505S	15.00
Z520M	4.00
Z521M	8.00
Z700U	3.00
Z749	0.60
Z759	19.85
Z800U	3.00
Z803U	18.95
ZA1000	12.50
ZA1001	1.50
ZA1002	1.50
ZC1040	8.00
ZM1005	8.00
ZM1020	8.95
ZM1021	8.00
ZM1023	7.95
ZM1041	14.00
ZM1082	9.00
ZM1084	10.00
ZM1177	9.00
ZM1202	55.00
ZM1263	4.00
ZM1612	3.00
1AC6	1.20
1B3GT	1.95
1B22	10.00
1B24	14.95
1B35A	29.50
1C1	2.50
1C5GT	2.50
1D5	2.50
1FD1	2.50
1G3GT	2.50
1L4	0.60
1L6	1.50
1LA6	1.00
1N5GT	2.50
1S2	0.55
1T4	0.70
1U5	1.00
1X2B	1.40
2B7	1.50
2C21	1.00
2C39A	23.50
2C39BA	39.50
2C40	37.00
2C40A	55.00
2C42	29.50
2C51	0.75
2C53	32.00
2CY5	1.50
2D21	0.95
2D21W	2.50
2E26	7.95
2J42	93.00
2K25	24.95
2K25 Raytheon	75.00
2K26	95.00
3A/107B	12.00
3A/108A	9.00
3A/109B	11.00
3A/110B	12.00
3A/141K	11.50
3A/147J	7.50
3A/167M	10.00
3A2	3.95
3A3A	3.95
3A4	1.10
3AL5	0.95
3AT2	3.35
3AW2	3.35
3B2	3.00
3B7	4.50
3B26	24.00
3B28	12.00
3C4	1.00
3C45	24.00
3CN3A	2.50
3CS6	0.95
3CX3	2.50
3CY5	1.50
3D6	4.50
3D21A	29.50
3D22	19.50
3W4GT	2.50
4B551B	115.00
4-65A	59.00
4-250A	65.00
4B32	19.50
4BQ7A	1.75
4C27	25.00
4C28	25.00
4CX250BI.T.T.	37.50
4CX250B EIMAC	49.00
4CX250B surplus ex-government	12.50
4CX250B tested ex-equipment	6.00
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4CX250K EIMAC	95.00
4CX350A	71.50
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5A152M	9.00
5A163K	10.00
5A170K	6.25
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5A-206K	10.00
5AM8	2.15
5AN8	1.20
5AR4	2.00
5AU4	1.50
5B.110M	10.00
5B-254M	14.50
5B-255M	19.50
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5C22	69.00
5R4GB	2.80
5R4GY	2.80
5T4	5.95
5U4G	1.95
5U4GB	2.50
5V4G	1.25
5Y3GT	1.95
5Z4GT	0.85
6/30L2	0.70
6A/203K	9.00
6A8G	1.50
6AB8	0.66
6AC7	2.00
6AF4A	2.50
6AF9	4.15
6AG5	1.50
6AG7	1.95
6AH6	1.50
6AJ4	2.00
6AJ7	2.00
6AK5	1.00
6AK6	2.00
6AL5	0.60
6AM4	3.25
6AM5	6.00
6AM6	1.50
6AN5	2.65
6AN8A	2.65
6AQ5	1.50
6AQ8	0.85
6AR8	3.95
6AS5	1.50
6AS6	1.50
6AS7G	4.50
6AT6	0.75
6AT8	1.75
6AU4	2.00
6AU6	0.95
6AV6	0.75
6AW8A	2.50
6B8G	1.50
6BA6	0.95
6BA7	4.50
6BA8A	3.50
6BC8	1.00
6BD4	1.50
6BD6	1.00
6BE6	0.72
6BF5	1.60
6BG6G	3.00
6BH6	1.95
6BH8	1.50
6BJ6	1.20
6BK4	4.00
6BK7A	1.95
6BM8	0.58
6BN4	1.65
6BN6	1.65
6BN7	4.50
6BN8	2.35
6BQ5	0.75
6BQ7A	0.72
6BL7GTA	3.95
6BL8	0.65
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6BR8A	2.15
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6BW4	1.50
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6C5	1.95
6C6	2.50
6C8G	1.50
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6CH6	6.95
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6CS6	0.75
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6EA8	2.50
6EB8	1.75
6EU8	1.75
6EW6	1.50
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6F6G	2.00
6F12	1.50
6F13	3.00
6F14	1.00
6F17	2.75
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6F22	0.70
6F23	0.60
6F24	1.25
6F25	1.25
6F28	1.25
6F32	1.25
6F33	17.00
6FG5	1.95
6GH8A	0.80
6GK5	1.50
6GK6	1.95
6GV7	2.50
6GW6	2.50
6H3N	1.10
6H6	1.35
6H6GT	1.95
6J4	1.10
6J4WA	3.15
6J5	2.50
6J6	0.65
6JB6A	3.95
6JE6C	4.95
6JS6C	4.95
6J7	4.15
6K7G	0.70
6K8Y	3.95
6KD6	5.50
6L1	2.50
6L19	3.95
6L6GC	2.95
6L6GC(GE)	3.95
6L6GT	1.15
6L7G	0.75
6LD20	0.60
6LF6	4.50
6LQ6	4.95
6N7	2.50
6N7GT	2.50
6P15	1.50
6P25	4.00
6P28	2.00
6Q7	1.20
6Q7GT	1.20
6S4A	1.50
6S7	1.10
6SA7GT	1.00
6SC7	1.50
6SG7	1.20
6SH7	1.20
6SJ7GT	1.20
6SK7	0.80
6SK7GT	1.20
6SL7GT	0.85
6SN7GT	0.95
6SQ7	0.80
6SS7	1.95
6U4GT	1.75
6U5G	1.50
6U8	0.85
6U8A	1.50
6V6GT	0.85
6X2N	1.00
6X4	1.50
6X5GT	0.55
6X5GTY	1.00
6X8A	2.25
7A7	2.00
7AD7	1.75
7B7	2.50
7C6	2.50
7E7	2.50
7Y4	1.95
8B8	2.50
8FQ7	1.95
10D2	1.25
10F1	0.75
10GK6	1.95
10P14	2.50
10P18	0.78
10LD11	1.00
10LD12	0.65
11E2	16.50
11E3	55.00
12AD6	1.50
12AG8	1.50
12AL5	1.00
12AT6	0.95
12AT7	1.15
12AT7WA	2.50
12AU6	1.50
12AU7	0.55
12AV6	0.80
12AX4GT	1.00
12AX7	0.65
12AX7WA	2.50
12AY7	3.95
12AZ7A	1.95
12B4A	3.50
12BA6	1.50
12BE6	1.05
12BH7A	2.50
12BL6	1.75
12BY7A	2.75
12CX6	1.20
12E1	17.95
12E14	28.00
12GN7	3.95
12HG7	4.50
12HG7A	4.50
12J7GT	0.70
12K5	1.00
12K7GT	0.60
12K8	1.10
12Q7GT	0.50
12SA7GT	1.00
12SG7	4.75
12SH7	1.00
12SK7	1.00
12SJ7	0.60
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12SQ7GT	1.50
13D3	3.20
13D7	3.20
13DR7	2.95
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14S7	1.00
17EW8	0.95
17JZ8	2.75
18D3	1.60
19G3	17.00
19H4	23.95
19H5	33.50
19Q6	9.00
20A2	10.50
20D1	0.70
20LF6	3.50
20L1	0.95
20P1	0.55
20P3	0.60
20P4	1.95
20P5	1.15
21LU8	2.50
24B1	39.50
25L6GT	1.75
25BQ6	1.75
29C1	19.50
30C17	0.40
30C18	1.48
30F5	0.95
30FL1	1.00
30FL2	1.35
30FL12	0.95
30FL13	1.10
30FL14	1.25
30L1	0.45
30L15	0.60
30L17	0.60
30P4MR	1.00
30P12	1.00
30P18	0.60
30P19	1.00
30PL1	2.50
30PL13	0.60
30PL14	1.75
31JS6A	5.50
33A/158M	19.50
35A5	4.50
35L6GT	2.00
35W4	0.70
35Z3	1.85
38HE7	4.50
40KD6	5.50
47	6.00
50C5	0.95
50CD6G	1.15
50JY6	2.95
52KU	2.00
61SPT	4.50
75B1	2.50
75C1	2.50
84	3.00
85A1	6.50
85A2	1.50
90AV	10.00
90C1	2.70
90CG	13.50
91AG	9.00
92AG	19.50
92AV	12.50
95A1	6.50
108C1	1.50
150B2	6.95
150C2	1.50
150C4	2.15
155UG	25.00
185BT	1.50
274A	15.00
307	5.00
328A	15.00
388A	17.50
425A5	8.00
431U	2.00
572B	35.00
705A	8.00
708A	8.00
715A	6.00
715C	45.00
725A	275.00
803	14.95
805	39.00
807	1.60
810	45.00
811A	12.95
813	18.50
813USA	45.00
829B	14.50
833A	60.00
866A	3.50
872A	19.00
873	60.00
884	5.50
930	9.95
931A	13.95
954	1.00
955	1.00
958A	1.00
1299A	0.60
1619	2.50
1625	3.00
1626	3.00
2050W	4.50
2050	2.75
3545	4.00
4313C	4.00
4328D	9.00
5642	9.50
5651	2.50
5654	1.95
5663	1.95
5670	3.25
5672	4.50
5687	4.50
5692	3.50
5696	2.75
5704	3.50
5718	6.15
5725	2.50
5726	2.50
5727	2.50
5749	2.50
5750	1.85
5751	2.95
5763	4.95
5814A	3.25
5840	3.50
5842	11.00
5894	39.50
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5963	1.75
5965	2.25
6005	1.85
6012	16.00
6021	3.65
6057	2.50
6059	3.75
6060	2.25
6062	4.50
6063	2.00
6064	3.25
6067	1.95
6072	4.20
6080	4.75
6080WA	8.50
6096	2.85
6132	10.00
6136	2.50
6146B	7.50
6157	2.50
6201	6.45
6211	2.50
6267	1.50
6350	2,00
6360	4.50
6386	14.50
6545	8.50
6550A	8.00
6870	11.50
6883B	9.95
6973	3.65
7025	2.50
7027A	4.50
7032	2.00
7059	2.50
7189	2.50
7189.	2.35
7193	7.50
7199	4.95
7247	2.00
7360	8.95
7475	5.00
7551	5.45
7558	9.45
7586	11.00
7587	26.95
7591A	4.95
7609	47.00
7868	3.95
8012	15.00
8042	45.00
8136	1.00
8245	107.50
8298A	6.50
8417	5.95
9001	1.50
9006	0.90
18042	10.00
18045	10.00

WIREWOUND RESISTORS

PREFERRED VALUES

4 Watt	4R7-1K8	0.15
	2K2-6K8	0.18
	10K	0.24
7 Watt	R47-4K7	0.18
	5K6-12K	0.19
	15K-22K	0.20
11 Watt	1R-10K	0.20
	15K-22K	0.24
17 Watt	1R-10K	0.26
	15K-22K	0.28

WW-2

BASES ETC.

B7G	0.15
B7G Skirted	0.30
B8G	0.70
B9A	0.20
B9A Skirted	0.30
B10B	0.16
B13B	0.50
8 Pin DIL	0.14
14 Pin DIL	0.15
14 Pin DIL/Q	0.30
16 Pin DIL	0.17
OCTAL	0.35
CANS	0.27
B9A PCB	0.15
B5	0.75
B9G	0.38

ZENER DIODES

BZX61 0.15

6V2 7V5 8V2 9V1 10V 11V 12V 13V 15V 16V 18V 20V 22V 24V 27V 30V 33V 36V 39V 47V 51V 56V 68V 75V

BZY88 0.07

2V7 3V 3V3 3V6 3V9 4V3 4V7 5V1 5V6 6V2 6V8 7V5 8V2 9V1 10V 11V 12V 13V 15V 18V 20V 24V 27V 30V

THERMISTORS

VA1040	0.23
VA1056S	0.23
VA1104	0.70
VA8650	0.45
VA1097	0.25

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CIRCLE 40 FOR FURTHER DETAILS.

MICROBOX II
A NEW MICRO CONCEPT

Do you remember the days when people built their own computers? Well they are back with a vengeance. MICROBOX, the most advanced design ever offered as a build-it-yourself system, offers every facility imaginable to the home constructor. Just look at the amazing specification of this easy-to-build project:

★ MC68B09E 8-/16-bit microprocessor
★ 64K main system ram + 128K alpha/graphic/simulated disc ram
★ Alpha display of 108 colums by 24 rows of 128 columns by 72 rows
★ True high-resolution graphics with 768 × 576 resolution High-speed hardware vector generation using NEC 7220 graphics controller. Point, line, rectangle, circle, arc and area fill facilities.
★ High-speed ram disc for fast data access
★ Up to 256K silicon disc eprom on plug-in eprom carrier
★ 8K system I/O support monitor plus added utility and boot commands
★ Integral eprom programmer
★ Floppy disc controller for two 5.25-inch 40- or 80-track drives
★ Battery backed realtime clock/calendar
★ Battery backed ram for storing system startup parameters
★ Two serial RS232 I/O ports. 50-19200 baud under software control
★ Centronics compatible printer output port
★ Parallel keyboard input port
★ Composite video and separate video/sync outputs
★ Buffered expansion buss for user added enhancements
★ Auto configuring 'FLEX' disc operating system boot program in monitor
★ 12×9.5in. through hole plated main PCB; 3×4in. eprom board.

'FLEX', which is supported by MICROBOX, is a well-proven, industry standard, disc operating system with a wealth of available software packages. Basic, Forth, Pascal, PL9 and C high-level languages as well as assemblers, word processors and electronic spreadsheet are currently available. Clever programming techniques have permitted the inclusion in the system monitor of a boot program that automatically loads and configures the operating system to the MICROBOX hardware requirements.

The on-board ram and eprom discs are seen by the operating system as conventional disc drives. The ram disc has the capacity of a 40-track single-density disc but with an access time 10 times that of a floppy disc. Eprom discs are supported by way of a plug-in eprom carrier which has provision for four 8, 16, 32 or 64K eproms into which can be programmed the operating system and any other often used programs by way of the built-in programmer. 'FLEX' supports up to four disc drives which in MICROBOX can each be allocated as floppy, ram or eprom types so providing, if required, a completely silicon configuration.

A startup kit for the advanced MICROBOX system is available and consists of: Bare PCBs, 8K system support monitor, 'FLEX' system support disc, constructional notes, system documentation, component supplier list.

PRICE: £95 + V.A.T.

'FLEX' disc operating system for MICROBOX, including editor and assembler: **£75** + V.A.T.

Send cheque to:

Micro Concepts

8 SKILLICORNE MEWS - QUEENS ROAD
CHELTENHAM - GLOUCESTERSHIRE GL50 2NJ
Telephone: Cheltenham (0242) 510525

CIRCLE 30 FOR FURTHER DETAILS.

The Wings Appeal Fund helps to maintain the RAF Association Home for Disabled and Chronic Sick. Care is essential for those who have served their country and who are in need. So please help by giving all you can for an emblem in WINGS WEEK in September or send a donation to show that you care.

Give as they Gave

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Malvern, Worcs. WR14 2TA.

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for the Wings Appeal Fund.
Name________
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Please tick if receipt required ☐
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ACCESS AND BARCLAYCARD Phoned Orders Welcome

2

CIRCLE 25 FOR FURTHER DETAILS.

Communications 84, Birmingham

Business communications seemed to be the central theme of the exhibition held at the NEC in Birmingham. The integration of communications services usually thought of as separate entities was emphasized by several exhibitors — the office computer terminal can also be a telex and teletex terminal and an autodial telephone as well as offering local computing, word processing, calendar and diary, calculator and directory. One such device launched by STC Telecommunications was Executel, a multipurpose work station with optional extension for a secretary which offerred most of the same facilities and a built-in intercom.

If you believe that electronics *is* communications, then the exhibition has something to offer to anyone interested in electronics. This is certainly confirmed by the variety of the products on show: anything from a complete satellite receiver station to a single transistor and almost anything that can be thought of that includes the prefixes tele or trans.

VOICE RECOGNITION SYSTEM

The facility for someone to speak to a computer and get it to obey has been appealing to the imagination for some time and systems are available but still in the process of development. Pye Telecommunications proudly demonstarted their system at Comm 84 which they claim is both complex and reliable. It may be used remotely by two-way radio or telephone and has been found to work in up to 100dB helicopter noise when test established that only one error resulted amongst 3200 recognitions.(Some of the techniques used in voice recognition systems were described by Tom Ivall in our last issue.) Pye Telecommunications Ltd, St. Andrews Road, Cambridge CB4 1DW.
EWW 218

SOLID-STATE BATTERIES

Batteries do not often hit the headlines but some new offerings from Chloride are interesting. Solid-state lead-acid batteries use highly absorbent, porous separators made from microscopically thin glass fibres, that take up the liquid electrolyte within their pores. Consequently, there is no free acid, and no risk of corrosion from fumes or acid spillage. Under normal operating conditions there is no loss of water and so it is possible to dispense with normal vents though there is a small safety vent in case of accidental over-changing. The Powersafe range includes 2V cells of 48 and 110Ah capacities and a 6V block of 80Ah. Another range, Powerstore, is available in 12 different sizes with capacities ranging from 3 to 240Ah, in 2, 4, 6 and 12V configurations. Chloride Power Storage, PO Box 5, Clifton Junction, Swinton, Manchester M27 2LR.
EWW 216

HAND-HELD TERMINALS/ TESTERS

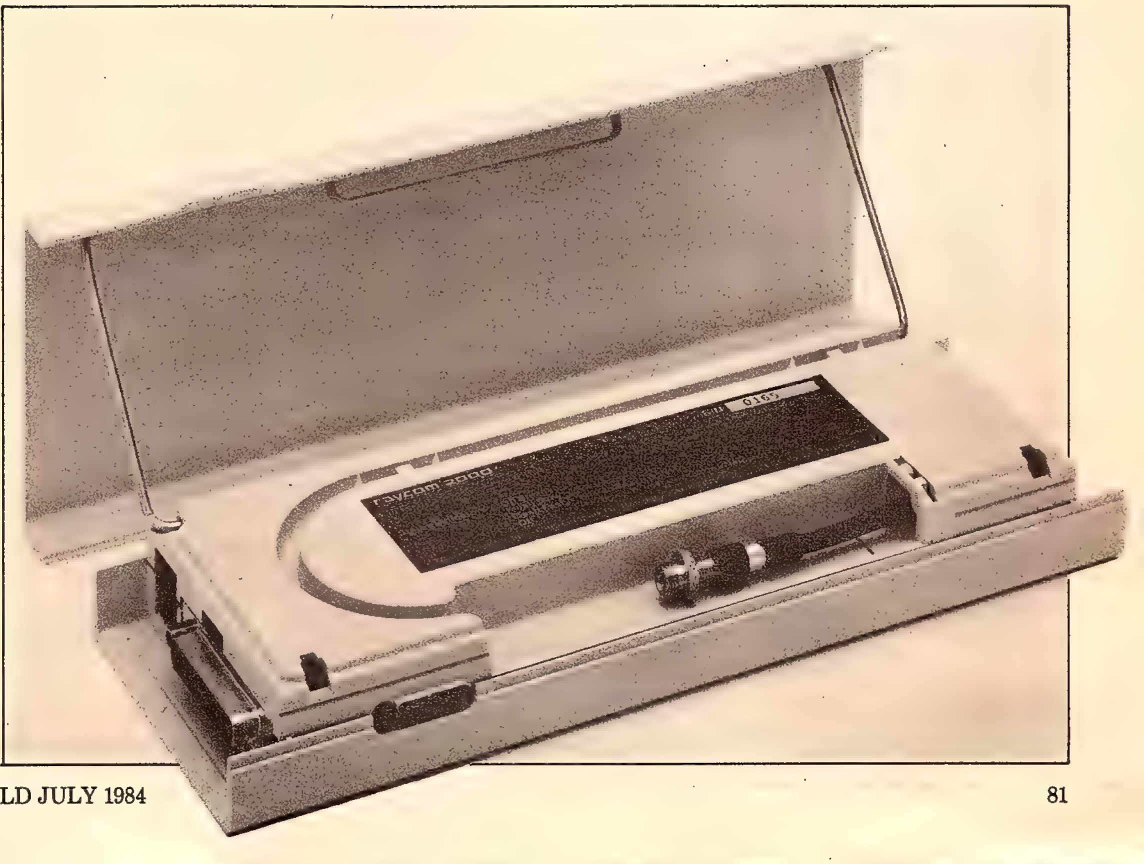
A number of hand-held terminals may also be used as support devices for communications equipment. Such devices made by G. R. Electronics have been used to test p.a.b.xs, multiplexers and other processor-based systems for commissioning and installation of such systems in the field. The 14B, for example has a 14-digit display, 92-character memory and RS232 and/or 20mA loop interfaces as standard. Options include a rechargeable battery pack making it completely independent of outside power sources, and RS422/432 interface for longer-cable signals.

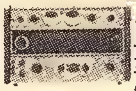
Larger memories and more facilities are offered by the 42B and 42C terminals which have 40-character displays, battery operation with memory protection, signalling up to 9600 baud and from 8K to 64K of ram. Different protocols are optional and the units can store diagnostic routines for on-site testing and can capture data for later analysis. The company also offers an acoustic coupler and a data recorder to complete a battery-operated system for the collection and transmission of data. G. R. Electronics Ltd, Fairoak House, Church Road, Newport, Gwent NPT 7EJ.
EWW 215

FIBRE-OPTIC MODEM

High data rates, low transmission line costs and freedom from electromagnetic interference are three of the several benefits claimed for Easydata's Raycom 2000 fibre-optic modem. A dual RS232 interface allows two separate peripherals to have access to the full duplex data channel operating at 100Kbit/s over a range of one km. Interconnection of RS232 interface between adjacent remote sites permits cascading and allows the system to be extended for up to 10km.

A fibre splicing technique has been incorporated into the system and this is claimed to take one third of the time needed normally to make splices and yet offers a high-fidelity connection into each modem. The modems are priced at £250 each and saving is claimed from the use of single strand fibres, lower in cost than the equivalent twin strand or screened twisted pair cables normally used. Easdata Ltd, 7 Charleton Rise, Welwyn, Herts AL6 9RP.
EWW 217





★ MARCONI SIGNAL GENERATORS ★

TF2002A/S (illustrated) 10kHz-72MHz. AM/FM. **£750**
TF2002. As above but AM only. **£450**
MARCONI TF1066B. AM/FM Generator. 10-470MHz. 0.2uV-200mV output. FM Deviation up to ±100kHz.
MARCONI TF995A/5. AM/FM Generator. Narrow deviation model 995 covering 1.5-220MHz. **£450.** TF2015. 10-520MHz. AM/FM. TF144H. AM 10kHz-72MHz **£295.**
MARCONI TF1064B/5. AM/FM Signal generator covering in three ranges 68-108, 118-185 and 450-470MHz. FM fixed deviations of 3.5 & 10kHz. AM fixed 30%. **£225**

★ 'DOLBY' NOISE WEIGHTING FILTERS ★

Cat. No. 98A. Noise weighting filters for CCIR/ARM signal-to-noise ratio measurements. As new units. **£40** each (+£1 p&p).

BECKMAN TURNS COUNTER DIALS

Miniature type (22mm diam.). Counting up to 15 turn "Helipots". Brand new with mounting instructions. Only **£2.50** each.

1000 WATT AUDIO AMPLIFIER

— for inter factory/office communication comprising two racks containing ten 100W Grampian audio amplifiers and receiver for background music, microphone and pre-amp controller. COMPLETE SYSTEM £550.

OPTICAL ISOLATORS

SPERRY UNIVAC M4000 opto-isolator units providing 2KV of insulation between Modems and Terminals. 25 way 'D' connectors (RS232C Interface) in and out. Measures 9×5×7". Complete with handbook .... **£25** — pp£2.

★★ STEPPER MOTORS ★★

Brand new stock of 'ASTROSYN' Type 20PM-A055 stepper motors. 28V DC. 24 steps per rev. 15 oz-in torque @ 100PPS. Body length 2½", diameter 2", shaft ¼" diam × 4¼" spirally threaded. Weight 16oz. Price each **£15** (p&p 50p). Connections supplied. INC. VAT.

TELEVISION SERVICE KIT

We have managed to obtain a stock of Labgear T.V. Service equipment affording vast savings on new price. All items are sold in full working condition and guaranteed.
LABGEAR CM6037/DB. UHF/VHF PAL COLOUR BAR GENERATORS Colour bars/cross-hatch/dot/blank raster/centre location. £80.
LABGEAR CM6004-PG. Monochrome UHF PATTERN GENERATORS. Grey Scale/variable level cross-hatch & Dot patterns. £40.
LABGEAR CM6016/SM. UHF SIGNAL STRENGTH METERS. Variable tuning Channels 25-65. Calibrated 4-range moving-coilmeter, 30µV-3mV. Battery powered. £45.
Please note all these prices INCLUDE VAT. Carriage + £2 each item.

P. F. RALFE ELECTRONICS

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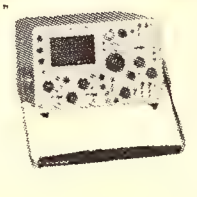
'OSCILLOSCOPES'

PLEASE PHONE FOR CURRENT STOCK



TEKTRONIX 453. Dual-trace 50MHz.
TELEQUIPMENT D75 Dual-trace 50MHz portable **£450**
HEWLETT-PACKARD 1707A Dual-trace 75MHz.
TRIO CS1575 5MHz Dual-trace **£250**

★★ TEST EQUIPMENT ★★

MEGAPHONES — 'EAGLE' MV8SN. New. £40.
BEAVER Model E57500 Automatic test equipment.
MARCONI TF868 LCR Bridge
MARCONI TF2604 Electronic Multi-Meter
MARCONI TF893A Audio Power Meters **£85.**
MARCONI TF2502 RF Power Meters. DC-1GHz. 10w fsd **£350.**
MARCONI TF2701 In-Situ Universal Component Bridge **£250.**
HEWLETT-PACKARD 3450A Multi-Function Digital Multi-Meter.
ROHDE & SCHWARZ 'SDR' AM Signal Generator 0.3-1GHz.
TEKTRONIX 2901 Time-mark Generator.
ROHDE & SCHWARZ Resonance Frequency Meter 470MHz-2.5GHz.
ROHDE & SCHWARZ Polyscop SWOB II.
METROHM 500V Insulation Testers Transistorised **£40** pp £1.50.
BRUEL & KJAER Heterodyne Voltmeter 0.5-240MHz.
AIRMEC Display Oscilloscope 279, 4-trace, 14x10" CRT **£195.**
RIKADENKI 3-channel Chart Recorder, Model B-341.

8" WINCHESTER

UNITED PERIPHERALS model 3100 Mini-disc drives (3 × 8" sealed plattens) capable of over 19MBytes storage. External power supply requirements are 24V @ 3A and 5V @ 4A. Little used condition, believed OK but at the unbelievable price of just **£125** are sold without guarantee. Price inclusive of VAT and carriage and copy of user-handbook.

★ SWEEPERS ★

TELONIC 2003 System. 800-1500MHz **£325**
TELONIC SM2000 with 500-900MHz plug-in **£175**
KNIGHT KG-687 3-220MHz. **£150**

8" SHUGART DRIVES

8" Shugart type SA800 Floppy disc drives: Small quantity available, single-sided up to 800KBytes of storage. Power requirements, 5V @ 1.3A. Little used, excellent condition. **PRICE £90** — inclusive VAT and carriage and copy of user-handbook.

★ TEKTRONIX ★

FILE MANAGER SYSTEM MODEL 4907 Option 31 (Third disc drive). 4051 Graphic System compatible. **GPIB (IEEE 488-1975)** compatible.

PLEASE NOTE. All the pre-owned equipment shown has been carefully tested in our workshop and reconditioned where necessary. It is sold in first-class operational condition and most items carry a three months' guarantee. For our mail order customers we have a money-back scheme. Repairs and servicing to all equipment at very reasonable rates. PLEASE ADD 15% VAT TO ALL PRICES.

★ COMPUTER PERIPHERALS ★

1.6MB 8" FLOPPY DISC DRIVES

New Stock

After our recent sell-out of the DRE7100 FDDs, we are pleased to offer another bargain package as follows: BRAND NEW American 'MFE Corp' model M-700 **DOUBLE-SIDED** 8"Disc Drives. Massive storage capability up to 1.6MBytes. Full IBM compatability. External power requirements are ±5V at 1.2A and +24V at 1.1A. Full spares/back-up available U.K. (Elcomatic's). Current list is over £315.

** NOW LOWEST PRICE EVER £180 — INCLUDING MANUAL INC CARRIAGE & INC VAT **

DRE 4000 — SERIES DRIVES

Data Recording Equipment 5+5MB exchangeable disc drives model 4000A. Brand new units for **£275** — inlcuding power unit and full technical manual.

★ DISK CARTRIDGES ★

Surplus BASF 12-Sector RK05 cartridges available . . . small quantity only remaining at **£15** each. Carriage each £1.50.

★ SWITCHING POWER SUPPLIES ★

The following DC power supplies are available now from stock in limited quantities. All fully tested and guaranteed.

3.5V @ 10 Amps	**£15**	15V16A(110V IN) ...	**£20**
5V @ 20 Amps	**£20**	5V @ 40 Amps	**£30**
5V @ 60 Amps	**£40**	19V @ 30 Amps.......	**£40**
+15V, −12V & +5V @ 11A, 4A and 40A			**£50**

ALL PRICES NOW INCLUDE VAT. CARRIAGE + £2 EACH.

★ CENTRIFUGAL BLOWERS ★

'TORIN' Type U62B1. 230V Cap'Start (supplied), very powerful (200W. 3,000rpm) centrifugal fans for large rack cooling or enclosure extraction applications. Overall dimensions 20x12 cms, outlet 6x4 cms. BRAND NEW. Surplus stock. **£15 each inc. VAT, pp £1.50.**

ROTRON INSTRUMENT COOLING FANS

Supplied in fully tested excellent condition, as follows:
115V, 4½×4½×1½" **£5.** 230V same size **£5.50.** 115V 3×3×1½" **£4.** 230V 3" size, brand new **£6.** Also small quantity 115V 4½" size, brand new **£6.** Postage each + 50p please.

WW10

CIRCLE 55 FOR FURTHER DETAILS.

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THE POWERFET SPECIALISTS

OEM USERS

Pantechnic present the most adaptable high-powered amplifier ever.

FET SYSTEM AMP

Features:
- HIGH POWER up to 1.2kW (single ended)
- LOW VOLUME. 1/15 Cubic foot inc. Heatsink
- VERSATILE. Delivers more than 1kW into ½ to 8 ohms

OR 2 × 600W into 2 to 8Ω
OR 4 × 300W into 2 to 4Ω (200W into 8Ω)
OR { 1 × 600W into 2 to 8Ω
1 × 300W into 2 to 4Ω
1 × 150W into 4 to 8Ω
Etc., etc.

Having been closely involved in a wide variety of OEM applications of their amp boards. Pantechnic became aware of numerous implementation problems often left untackled by other amp board manufacturers. These problems specifically of size and thermal efficiency became particularly aggravated at high powers and considerably lengthened OEM product development time.

By including thermal design in the totality of board design it has been possible to reduce the size of the electronics, and increase the efficiency of the transistor to heatsink thermal circuit. The combined effect of this has been to dramatically increase the volumetric efficiency of the amplifier/heatsink assembly. The **SYSTEM** Amp offers 1.2kW of power in a space of 180mm x 102mm × 77mm, excluding PSU and Fan.

The basis of this considerable advance is the PANTECH 74 Heat Exchanger, designed and manufactured by us. By eliminating the laminar air flow found in conventional, extruded heatsinks, heat transfer to the environment is greatly enhanced.

The flexibility of the 1.2kW amp stems from its division into 4 potentially separate amplifiers of 300W each (downrateable with cost savings to 150W). These can be paralleled, increasing current capability or seriesed (bridged in pairs) doubling voltage capability. In consequence a large variety of amplifier/load strategies can be implemented

As ever Pantechnic offer a full range of customising options including DC coupling, ultra-high slew, etc. Contact Phil Rimmer on 01-361 8715 with your particular application problem.

P.S. Specs, as ever, are exemplary.

A wide range of other amplifiers and other modules available.

Price and Delivery
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132 HIGH ROAD,
NEW SOUTHGATE,
LONDON NI1 1PG

Technical Enquiries
contact
Phil Rimmer
on
01-361 8715

CIRCLE 67 FOR FURTHER DETAILS.

M & B RADIO (LEEDS)

THE NORTHS LEADING USED TEST-EQUIPMENT DEALER

OSCILLOSCOPES.

Tektronix 465 100MHZ Dual-Trace Delay Sweep	900.00
Tektronix 7403N Main-Frame	750.00
Hewlett-Packard 182A Main-Frame	550.00
Hewlett-Packard 182C Main-Frame	395.00
Hewlett-Packard 182A 4 Channel Plug-In and 1825A Time-Base and Delay Generator	1000.00
Telequipment D83 50MHZ Dual-Trace	450.00

ANALYSERS

Hewlett-Packard Fourier Analyser 5451B with 7900A Disk-Drive and Low-Pass Filters A to D Converters Etc	2,500.00

RHODE-SCHWARZ

SHF Signal-Generator 1.7 to 5.0 GHZ	850.00
VHF Signal-Generator 25 to 480MHZ SLSV	185.00
Sweep Signal-Generator 400 to 1200 MHZ SWU	225.00
UHF Signal-Generator 300 to 1,000 MHZ SDR	145.00
UHF Test Receivers 280 to 4600 MHZ USVD	175.00
Selentomat Type USWV	225.00
Stereodecoder Standard MSDC	225.00
UHF Power Signal-Generator SCRD 275 to 2750 MHZ .05 to 50 watts	400.00
Frequency Synthesiser XUA 30 HZ to 30 MHZ	400.00
Transmission Measuring Line 75 to 305MHZ	400.00
Reflektometer 300 to 4200MHZ ZDB	150.00
Unbalanced Standard Attenuator DPU 0—1500 MHZ 50ohms	50.00

MISCELLANEOUS

Avo RM215F/3 Ac Breakdown Tester	195.00
Avo Universal Bridge B150 MK2	95.00
Advance X-Y Recorder HR96	65.00
Clare Multiple Earth Loop-Tester V144	75.00
Fluke RMS Differential Voltmeter 931B	450.00

HEWLETT-PACKARD.

431B Power Meter	75
8052A Impulse Sound Level Meter	200.00
3406A Broadband Sampling Voltmeter	250.00
3480A Digital Voltmeter	135.00
1900A Pulse Generator 1925A Word Generator	POA
Marconi TF144H/4 Standard Generator	150.00
Marconi 801D Signal-Generator	100.00
Radiometer SMG1 Stereo Generator	250.00
Racal 9908 Counter Timer 1.1GHZ	500.00
Racal Universal Counter 9835	100.00
Wayne Kerr Logarithmic LCR Bridge B500	295.00
Marconi Electronic Voltmeter TF2604	125.00
Marconi X-Y Displays TF 2212	100.00
Marconi X-Y Displays TF2213/1	250.00

HEWLETT-PACKARD PSU.

6433B Power Supply 0-36v 10A	195.00
6448B Power Supply 0-600v 1.5	195.00
6453A Power Supply 0-15v 200A	275.00
Bradley Pulse Generator 176B	195.00
CCTV Video Cameras 2/3 Vidicon	75.00
Hewlett-Packard Time Interval Probes 5363A	400

RECEIVERS

Eddystone 830/7 300Kcs to 30Mhz	250.00
Racal RA17L Communications Receivers	300.00
Mercer 155 Electronic/Pneumatic Gauging System	175.00
General Radio Capacitane Bridge 1617A	350.00

All Prices plus V.A.T. SAE Enquiries.

WANTED

Test Equipment, Receivers, Valves, Components, Cable, PCB's Etc Top Prices Paid.

86 Bishopgate Street, LEEDS LS1 4BB. 0532-435649

CIRCLE 71 FOR FURTHER DETAILS.

AWARD-WINNING TAPE STREAMER

Using standard 0.5in computer tape the 9800 tape streamer from Thorn EMI Datatech may be used as archival back-up for hard disc data and for transferring data from mini to mainframe computers. The 9800, while taking a standard reel of tape is amazingly small and the combination of electronic, mechanical, and software design, combined with its ergonomic and aesthetic appeal has won for it a Design Council award.

The combination of hard disc and tape has become established in main frame computer usage for some time. With many peripherals and minicomputers however there has been a lot of reliance on floppy or hard discs and a system failure can lead to the loss of valuable data. The use of a back-up or archival tape can overcome the vulnerability of such a system. Datatech recognised a need for a high-speed, high-capacity desk-top tape store which was comparatively low in cost, hence the development of the 9800. Compatible with any computer system, the machine can automatically lace the tape through the tape path and onto the take-up hub. The tape cannot be put in the wrong way round, the machine will refuse to accept it and signal an error. Internally, all circuits are on plug-in cards and there are self-diagnostic testing routines built in for fault findings. As a trump card Thorn EMI are hasty to point out that the system is compatible with the IBM PC and expect to find a large market for the device amongst micro users. Thorn EMI Datatech Ltd, The Mill, Wookey Hole, Wells, Somerset BA5 1BB. EWW 210

NUJ/Reed International dispute
This space is one result of the continuing dispute between members of the National Union of Journalists and Reed International subsidiaries Business Press International, Butterworths, Hamlyn Books and IPC Magazines.

ADAPTIVE H.F. RADIO

A radio system which improves frequency management for communication networks that have several transceivers is announced by Racal Messenger. The VRM455OFS combines a frequency-scanning receiver with a selective call transmitter. It monitors up to ten pre-selected frequency channels, locks automatically onto a received signal and decides if it is the station being addressed before warning the operator of an incoming message. This facility enables the optimum receiver frequency to be selected, from the ten pre-programmed channels, by the transmitter station, taking into account the existing h.f. propagation conditions.

Sets of the transceivers can have a different selection of channel frequencies so that networks can interlace or overlap while being secure from each other. With a transmitting power of 100 or 120W the synthesized frequency transceivers operate between 1.6 and 30MHz. A small display indicates the selected channel while an audible tone and a flashing light warn the operator of an incoming call. Racal Messenger Ltd, 5 Bennett Road, Reading, Berks RG13 1LJ. EWW 211

WORD-PROCESSED TELETEX

An adaptor has been devised by BT to provide the Merlin word processor with the facility to connect to teletex services. This, claims Merlin, the business machine branch of British Telecom, "provides the ability to exchange text information in a rapid error-free and cost effective manner". Using the de-facto standard for electronic mail, the system will communicate with any other teletex terminals, of any manufacture. The system has been developed by BT research engineers and has undergone a series of network-user trials prior to its public launch. As well as providing teletex protocol, the system offers auto dialling, auto answer for unattended operation, store and forward operation allowing messages to be transmitted at times when the charges are lower, automatic logging of all documents sent and received and a full character set ensuring that the copy is received exactly as sent. Future expansion will include inter-working with telex and packet switched services. Merlin don't provide an address: all you need do is pick up a telephone, dial 100 and ask for Freephone Merlin. EWW 212

DATA MULTIPLEXER

The Polynet local-area network from Logica has been enhanced by the introduction of a highly flexible multiplexer, Polyline, to interface computers with the network. The device may be used with any computer or peripheral device with an RS232 port to give it access to the network which may also be used with high-speed computer-to-computer traffic. Polyline may be used to connect normally incompatible networked or stand-alone devices. In addition the multiplexer may be used to interface a terminal with external services, such as electronic mail, which may be available to the host computer. Each multiplexer can support up to eight asynchronous channels which operate full duplex and support communications over the network for six signal lines. Control of the network can be undertaken by a Terminal Manager software package. The Polynet/Polyline combination can be used to provide high-speed links between a number of otherwise incompatible mini and microcomputers from different manufacturers. Logica VTS Ltd, 84 Newman Street, London W1A 4SE. EWW 213

VOICE-OPERATED SWITCH

A microphone/switch combination that allows hand-free operation of a transceiver has many uses. The Sonic Tornado voice-operated switch is such a device and uses a inertial throat microphone or noise cancelling microphone. The unit can be used with ear-hanger headsets, or be fitted into breathing masks and helmets. Field trials have established that the sets will respond in 8ms when used by firemen with breathing aparatus, or in fully enclosed anti-radiation or laboratory suits. It has also been tested successfully by RAF search and rescue helicopter crews and by free-fall parachutists. Sonic Helmets Ltd, Communications Centre, 202 Bradford Road, Castle Bromwich, Birmingham B36 9AA. EWW 214

Sowter Transformers

With 42 years' experience in the design and manufacture of several hundred thousand transformers we can supply

AUDIO FREQUENCY TRANSFORMERS OF EVERY TYPE

YOU NAME IT! WE MAKE IT!

OUR RANGE INCLUDES:

Microphone transformers (all types), Microphone Splitter/Combiner transformers, Input and Output transformers, Direct Injection transformers for Guitars, Multi-Secondary output transformers, Bridging transformers, Line transformers, Line transformers to G.P.O. Isolating Test Specification, Tapped impedance matching transformers, Gramophone Pickup transformers, Audio Mixing Desk transformers (all types), Miniature transformers, Microminiature transformers for PCB mounting, Experimental transformers, Ultra low frequency transformers, Ultra linear and other transformers for Transistor and Valve Amplifiers up to 500 watts, Inductive Loop transformers, Smoothing Chokes, Filter, Inductors, Amplifier to 100 volt line transformers (from a few watts up to 1,000 watts), 100 volt line transformers to speakers, Speaker matching transformers (all powers), Column Loudspeaker transformers up to 300 watts or more.

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CIRCLE 47 FOR FURTHER DETAILS.

AA117	0.09
AA119	0.09
AAY32	0.09
AC107	0.28
AC126	0.17
AC127	0.15
AC128	0.15
AC128K	0.23
AC141K	0.23
AC142K	0.22
AC153K	0.23
AC176	0.18
AC176K	0.20
AC187	0.15
AC187K	0.20
AC180	0.17
AC188K	0.23
ACY18	0.48
ACY19	0.48
AD142	0.60
AD149	0.45
AD161	0.22
AD162	0.22
AF124	0.25
AF125	0.25
AF126	0.25
AF127	0.25
AF139	0.22
AF239	0.22
AL112	0.70
AL113	0.80
ASZ15	1.00
ASZ17	1.00
AU110	1.10
AY102	1.80
AY106	1.80
BA145	0.10
BA148	0.10
BA154	0.06
BA157	0.12
BB101	0.13
BB103	0.16
BB105B	0.18
BB205B	0.24
BC107	0.07
BC108	0.07
BC109	0.07
BC115	0.10
BC118	0.11
BC140	0.19
BC141	0.19
BC142	0.19
BC143	0.19
BC147	0.05
BC148	0.05
BC149	0.05
BC157	0.05
BC159	0.05
BC182	0.06
BC182L	0.06
BC183	0.06
BC183L	0.06
BC184	0.06
BC184L	0.06
BC212	0.06
BC212L	0.06
BC213	0.06
BC213L	0.06
BC214	0.06
BC214L	0.06
BC237	0.07
BC238	0.07
BC300	0.16
BC301	0.18
BC302	0.18
BC303	0.18
BC327	0.06
BC382	0.06
BC337	0.06
BC328	0.06
BC557	0.06
BCY32	1.50
BCY33	1.50
BCY34	1.50
BCY42	0.20
BCY56	0.16

BCY70	0.16
BCY71	0.16
BCY72	0.16
BD115	0.26
BD124P	0.50
BD124	1.10
BD128	0.35
BD131	0.25
BD132	0.25
BD135	0.20
BD136	0.20
BD137	0.20
BD138	0.20
BD139	0.20
BD140	0.20
BD144	0.90
BD150	0.30
BD157	0.38
BD158	0.38
BD166	0.30
BD175	0.30
BD177	0.30
BD179	0.32
BD181	0.45
BD201	0.33
BD202	0.38
BD203	0.42
BD204	0.42
BD222	0.31
BD225	0.31
BD232	0.31
BD237	0.21
BD238	0.24
BD433	0.28
BD437	0.28
BD535	0.38
BD536	0.38
BD537	0.40
BD538	0.40
BDX32	1.00
BDX65	[illegible]
BF180	0.16
BF181	0.18
BF183	0.20
BF184	0.20
BF185	0.20
BF194	0.05
BF195	0.05
BF196	[illegible]
BF199	0.06
BF200	0.16
BF257	0.18
BF258	0.18
BF259	0.18
BF336	0.20
BF337	0.20
BF338	0.20
BF362	0.30
BF422	0.21
BF458	0.19
BF459	0.19
BFX29	0.20
BFX84	0.20
BFX85	0.20
BFX87	0.15
BFX88	0.15
BFY50	0.14
BFY51	0.14
BFY52	0.14
BFY56	0.25
BYF57	0.25
BFY64	0.25
BR100	0.14
BSX19	0.15
BSX20	0.15
BSX21	0.16
BSX26	0.16
BSX29	0.19
BZX76	0.18
BT106	0.90
BT109	0.90
BT116	0.80
BT119	1.00
BT120	1.00
BU104	1.00
BU106	0.80
BU108	1.00
BU110	1.10

BU111	1.40
BU126	0.70
BU204	0.75
BU205	0.70
BU208	0.75
BU208A	0.80
BU208D	1.20
BU326	0.85
BU406	0.85
BU407	0.75
BU408	1.00
BU500	1.10
BU526	0.80
BY126	0.06
BY127	0.08
BY133	0.08
BY164	0.22
BY176	0.85
BY179	0.35
BY182	0.32
BY184	0.32
BY187	0.32
BY196	0.20
BY206	0.11
BY207	0.11
BY223	0.72
BYX10	0.15
CA270	0.40
CA3086	0.25
CA3089	1.50
CA3240	0.90
C106D	0.23
MC1327	0.70
MJ2500	1.00
MJ2501	1.10
MJ2955	0.55
MJ3000	1.15
MJ3001	1.15
MJE29A	0.30
MJE30A	0.30
MJE340	0.25
MJE350	0.80
MJE520	0.30
MJE2955K	0.90
OA47	0.06
OA90	0.04
OA91	0.04
OA200	0.07
OA202	0.07
OC28	1.00
OC29	0.80
OC35	1.00
OC45	0.50
OC71	0.30
OC72	0.50
OC200	1.80
OCP71	1.00
ORP12	1.00
ORP60	1.00
ORP61	1.00
R2008B	0.80
R2010B	0.80
SAS560	1.10
SAS570	1.10
SN76003N	1.40
SN76013N	1.40
SN76023N	1.40
SN76033N	1.50
SN76110N	0.70
SN76115	0.70
SN76226	0.90
SN76227	0.80
T2800D	0.52
TAG06-60	0.42
TAG521 200	0.72
TAG4443	0.76
TAG4444	0.76
TAA550	0.16
TBA120S	0.45
TBA395	0.60
TBA396	0.60
TBA520	0.75

TBA530	0.75
TBA540	0.75
TBA560	0.70
TBA800	0.35
TBA810S	0.60
TBA820	0.75
TBA920	0.80
TBA950	0.80
TBA990	0.80
TCA800	0.80
TCA940	0.85
TDA1170	0.90
TDA1412	0.60
TDA2002	0.80
TDA2003	1.50
TDA2020	1.40
TDA2030	1.40
TDA2522	0.80
TDA2530	0.80
TDA2532	0.75
TDA2540	0.70
TDA2560	0.70
TDA2593	0.80
TDA2690	0.70
TIP29	0.15
TIP29A	0.22
TIP29C	0.25
TIP30	0.16
TIP31A	0.24
TIP32	0.24
TIP32A	0.24
TIP33	0.50
TIP34	0.50
TIP41A	0.22
TIP41C	0.25
TIP42A	0.22
TIP42C	0.25
TIP47	0.40
TIP48	0.40
TIP49	0.40
TIP110	0.47
TIP112	0.54
TIP115	0.45
TIP117	0.56
TIP120	0.43
TIP121	0.46
TIP122	0.47
TIP125	0.47
TIP126	0.56
TIP127	0.56
TIP2955	0.34
TIP3054	0.38
TIP3055	0.34
TIS61	0.15
TIS90	0.15
TIS91	0.18
2N 2904	0.20
2N 2905	0.20
2N 2906	0.18
2N 2907	0.18
2N 2926	0.08
2N 3019	0.28
2N 3063	0.18
2N 3054	0.35
2N 3055	0.32
2N 3055H	0.38
2N 3440	0.58
2N 3442	0.85

2N 3771	0.85
2N 3772	0.90
2N 3773	1.00
2N 4031	0.25
2N 4036	0.25
2N 4037	0.25
2N 4443	0.76
2N 4444	0.76
2N 5061	0.20
2N 5294	0.30
2N 5296	0.30
2N 6106	0.40
2N 6107	0.40
2N 6109	0.40
3N 128	0.55
3N 143	0.65
IN 914	0.02
IN 4001	0.04
IN 4002	0.04
IN 4003	0.04
IN 4004	0.04
IN 4005	0.04
IN 4006	0.04
IN 4007	0.06
IN 4148	0.02
IN 5400	0.09
IN 5401	0.10
IN 5402	0.10
IN 5403	0.11
IN 5404	0.11
IN 5405	0.12
IN 5406	0.13
IN 5407	0.13
IN 5408	0.13

VOLTAGE REGULATORS

7803	0.35
7812	0.35
7815	0.35
7818	0.35
7824	0.35
7905	0.35
7912	0.40
7915	0.40
7918	0.40
7924	0.40
78L05	0.28
78L12	0.28
78L15	0.28
74L18	0.28
74L24	0.35
LM309K	1.00
LM317K	2.20
LM317T	1.80
LM323K	4.20
LM723	0.32
78HGKC	5.70
78H05KC	5.20
78GU1C	1.90
79GU1C	2.15
79HGKC	6.70

JAPANESE TRANSISTORS

2SA73	0.30
2SA104	0.32
2SA198	0.22
2SA203	0.30
2SA473	0.37
2SB54	0.25
2SB77	0.32
2SB337	1.20
2SB405	0.22
2SC460	0.21
2SC495	0.60
2SC733	0.40
2SC1161	1.10
2SC1172Y	1.50
2SC1279	0.24
2SC1306	1.00
2SC1307	1.00
2SC1520	0.25
2SC1969	1.30
2SC2029	1.20
2SC2078	1.20
2SC2122A	2.00
2SC2952	0.27
2SD234	0.37
2SK135	4.00
MB3712	1.50
TA7205	1.50
UPC575	1.00

ICS SOCKETS

8 pin	0.06
14 pin	0.08
16 pin	0.09
18 pin	0.12
20 pin	0.14
22 pin	0.16
24 pin	0.18
28 pin	0.20
40 pin	0.25

VALVES

DY87	0.53
DY802	0.45
ECC82	0.40
ECC83	0.43
ECC83	0.40
ECC85	0.40
ECH81	0.49
ECH84	0.52
ECL80	0.57
ECL82	0.25
ECL84	0.57
ECL85	0.57
ECL86	0.49
EF80	0.31
EF85	0.34
EF89	0.43
EF183	0.45
EF184	0.53
EL34	1.90
EY86	0.31
EY87	0.31
PC97	1.00

PCC85	0.42
PCF80	0.58
PCF200	1.35
PCF801	1.10
PCF802	0.57
PCF806	1.15
PCH200	1.00
PCL81	0.54
PL519	4.50
PCL82	0.63
PCL84	0.50
PCL85	0.55
PCL86	0.55
PCL805	0.55
PFL200	0.85
PL36	0.80
PL504	0.95
PL508	1.90
PY81	0.70
PY88	0.48
PY500A	1.60

ZENERS

400MV BZY88 Range 2V7 to 39V0	060
13W Zeners BZX61 Range 2V7 to 39V0	120

MEMORIES

2114	2.00
2716	3.00
2532	4.00
2732	4.00
2764	7.00
4116	0.75
6116	6.00
LM324	0.30
LM380	0.50
LM381	1.00
LM709 Dil	0.30
LM723	0.32
LM741 Dil	0.15
LM741 Met	0.45
LM3900	0.25
NE555	0.15
NE556	0.40
BYX55/350	0.30
BYX55/600	0.30
BYX55/600	0.30
BYX55/800	0.32
BYX70/500	0.29
BYX70/500	0.31
BYX70/800	0.36
BYX71/600	0.80

LED

LED 3mm RED	0.05
LED 3mm YELLOW	0.10
LED 3mm GREEN	0.10
LED 5mm RED	0.05
LED 5mm YELLOW	0.10
LED 5mm GREEN	0.10

BRIDGE RECTIFIERS

1A/50V	0.16
1A/100V	0.18
1A/200V	0.19
1A/400V	0.21
1A/600V	0.23
1A/800V	0.28
2A/100V	0.35
2A/200V	0.36
2A/400V	0.42
2A/600V	0.54
2A/800V	0.58
3A/200V	0.66
3A/400V	0.68
3A/600V	0.78
6A/200V	1.00
6A/400V	0.80
25A/100V	1.60

ELECTROLYTIC

4700UF-16V CAN	0.20

TRIPLERS

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CIRCLE 13 FOR FURTHER DETAILS.

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- *No signal switch "clicks" by use of a unique 'fade up/down' system.*
- *Sophisticated zone switching arrangement with easy to-program matrix*
- *Mainframe systems may be cascaded to provide for a very large number of input sources*
- *Priority — first come, first served — mixed source switching*

For performance, versatility and economy, the message is loud and clear: Series 8000 from Whiteley Electronics, the British company with over 50 years of sound experience.

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Whiteley
AUDIO SYSTEMS

Over half a century of sound experience

Whiteley Electronics Limited Victoria Street Mansfield Notts NG185RW England Telephone (0623) 24762 Telex 377426

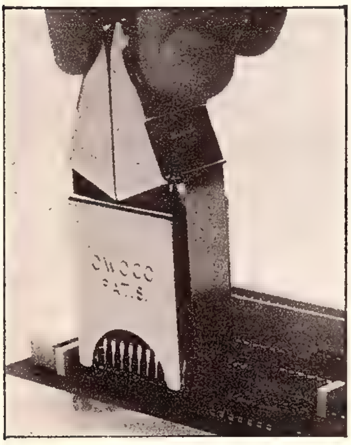
CIRCLE 73 FOR FURTHER DETAILS.

PCB TOOLS

Repair and reworking of printed circuit boards is claimed to be simple and economical with miniature power tools from Foredom. Based on a motor unit and a flexible shaft drive the tools can be used to clean, alter and modify boards with a variety of attachments including buffs, brushes, sanding discs, abrasive wheels, ball cutters, burrs, drills and saws. Power is supplied by a 0.1hp electric motor through the flexible shaft at speeds from zero to 14 krev/min. Speed may be varied by a foot control. Hirsh Jacobson Merchandising Co. Ltd, 91 Marylebone High Street, London W1.
EWW 219

PROM REMOVER

New from Sweden are these i.c. removers which can pluck a rom from its socket without damage to the p.c.b. or to the circuit. For once the model numbers seem to make some sense; 2428 is for 24 and 28-pin devices while 3640 is for 36 and 40 pins. Called Prom-outs they are available from Welwyn Tool Co. Ltd, 4 Black Fan Road, Welwyn Garden City, Herts AL7 1EH.
EWW 220



TASCAM
TASCAM
TASCAM
TASCAM
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REEL TAPE RECORDERS

Analogue sound recorders designed for audio and video production work have been manufactured by Tascam. The 40 series comprises three different machines; the 42 with two tracks for stereo and 7.5 or 15 in/s tape speed; the 44 with four tracks and the same two speeds, and the 48 with eight tracks on 0.5in tape and a single speed of 15in/s. The machines can all use the SMPTE time codes and may be locked on to time code synchronizers, and search and cue facilities are available using the real-time counters. The machines use ceramic capstans to improve performance and minimize wear. Three heads are used and flux levels of 250nWb/m or 320 may be accommodated. NAB or IEC/DIN equalization may be used. The tape transport is heavy-duty, servo controlled with claimed low wow and flutter figures. Optional plug-ins provide synchronization with automated broadcast equipment or remote transport control. Each machine has both XLR (balanced 600Ω connections with a recording-level headroom of +28dBm) and phono (unbalanced 10kΩ) connections. Internal switching enables a +8dBm operating level.

Tascam see the use of the 40 series to be in smaller studios, video post-production, dubbing, and in training and education. In contrast they have taken the opportunity to upgrade the two series 50 machines which they claim to be in the full professional league. The 50 series now includes the —10dBv phono outputs and balanced +4dB balanced connections. The two-track 52 now has front-mounted input and output level controls with pre and post fader switching. The 50 series also offers remote control facilities for the transport and for selection of channels. All switching and preset controls are available on the front panel. Model 58 offers eight tracks on 0.5in tape. Both the 52 and 58 machines have their bias and equalization set for use with high output/low noise tapes such as Scotch 226 or Ampex 456, and may be easily adjusted to the correct parameters for such tapes. If a particular low-bias tape is to be used, a small modification is needed to adjust the preset's range. Distributor: Harman (Audio) UK Ltd, Professional Products, Mill Street, Slough, Bucks SL2 5DD.
EWW 221

SERIAL COMMUNICATIONS

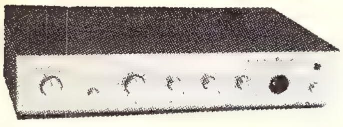
Much more than a dumb buffer is the serial communications card which includes an on-board M68000 processor running at 8MHz. The SCC-01 can also have up to 32Kbytes of local program stored in eprom or fusible-link prom, and 128Kbytes of dynamic ram. The unit communicates with a host processor through a VME bus by means of interrupt generation and 4Kbytes of dual port ram. There are twelve u.a.r.ts on the card, eight of which are used for several peripherals while the other four are available for monitoring in receive-only mode. The u.a.r.ts have programmable data rate generation and can detect breaks in a data stream. Four of the u.a.r.ts have been designated as fast channel devices and, if selected all four can be operated in synchronization at up to 1Mbaud. Plug-in daughter boards provide conversion from t.t.l. level to RS232, RS422 or 20mA level. The double Eurocard with the system on board has been designed for use in industrial environments and can operate within a temperature range of 0 to 70°C, and a relative humidity of up to 9%. All boards undergo a 48h temperature/power cycling programme. Manufactured by Wormald Data Systems, they may be obtained from Unit-C Ltd, Dominion Way West, Broadwater, Worthing, West Sussex.
EWW 222

FORTH EPROM PROGRAMMER

A single Eurocard accommodates a circuit which can be used to program, read, verify, and copy eproms. The TDS960 card is used in conjunction with the single-board TDS 900 Forth computer and the programmer software is provided on rom as well as a listing. The Forth listing enables the user to add any particular programming needs as may be required. The programmer card is the same cost as the TDS 900 c.mos computer; both are £179.95. Triangle Digital Services Ltd, 100A Wood Street, London E17 3HX.
EWW 223

HART

LINSLEY-HOOD
300 SERIES AMPLIFIERS



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One inexpensive test cassette enables you to set up VU level, head azimuth and tape speed. Invaluable when fitting new heads. Only **£4.66** plus VAT and 50p postage.

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TUNER AND PRE-AMP MODULE

Matching unit to above. Contains Long, medium and short wave AM tuner. Stereo FM tuner and pre-amp with switched inputs for tuners, tape and pickup. Complete with flywheel drive and cord assembly. Size 400 × 220 × 63mm.
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Complete record and replay circuits for very high quality low noise stereo cassette recorder. Circuits are optimised for our HS16 Super Quality Sendust Alloy Head. Switched bias and equalisation to cater for chrome and feric tapes. Very easy to assemble on plug-in PCBs. Complete with full instructions.
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Beautiful, precision made High Quality variable capacitor tuned FM Front End with Dual-gate MosFet. The tuning capacitor also has 2-AM Gangs and built in 3:1 reduction gear. Covers full FM range of 87 to 109MHz. Supply needed is 12V at only 30mA Max. Inputs are provided for AGC and AFC signals. These have recently been on special offer from another supplier at **£4 plus VAT. OUR PRICE IS ONLY £3.99 INCLUDING VAT AND POSTAGE!** Circuit if required **35p.**

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A really super buy for the computer enthusiast. These decks, made by Burroughs, use a capstanless cassette mechanism to record and replay data at 10 and 30 inches per second. The read after write head uses an NRZ system with separate tracks for clock and data. power supplies of 5v, -12v and +12v are required. Front panel is 137mm square and the unit is 200mm deep including rear connector. Offered in good ex-equipment condition at a fraction of origínl cost, ONLY **£44.50** inc. VAT and postage. Data inc. circuits and layouts of PCBs £3.50.

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HQ551 4-Track Head for auto-reverse or quadrophonic use. Full specification record and playback head **£9.73**
Please consult our list for technical data on these and other Special Purpose Heads.
MA481 Latest version Double Mono (2/2) Record/Play head. Replaces R484 .... **£8.90**
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H561 Metal Tape Erase Head. Full double gap **£4.90**
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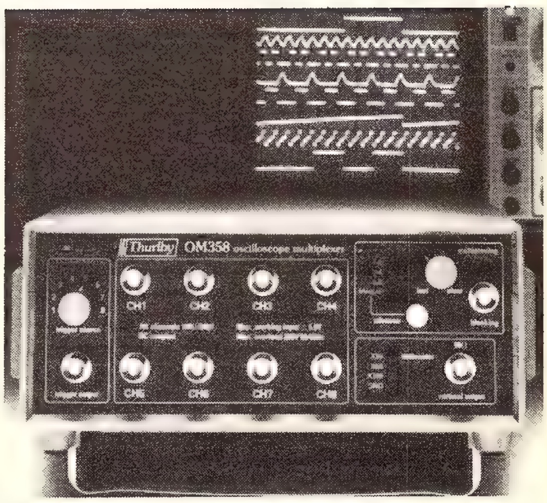
New Thurlby OM358 multiplexer £169+vat



The Thurlby OM358 gives any oscilloscope an 8 channel display. Observing many waveforms simultaneously can be essential when analysing sophisticated equipment. Application areas include microprocessor based products, data transmission systems, A to D converters, frequency synthesizers etc.
The OM358 is ideal for digital equipment (it can often solve problems that would otherwise need a fast logic analyser) but, unlike dedicated logic test instruments, it is equally suited to analogue waveforms.
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Thurlby
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New Road, St. Ives, Cambs.
PE17 4BG **Tel: (0480) 63570**

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CIRCLE 31 FOR FURTHER DETAILS.

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★ 80 characters × 24 lines ★

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CIRCLE 17 FOR FURTHER DETAILS.

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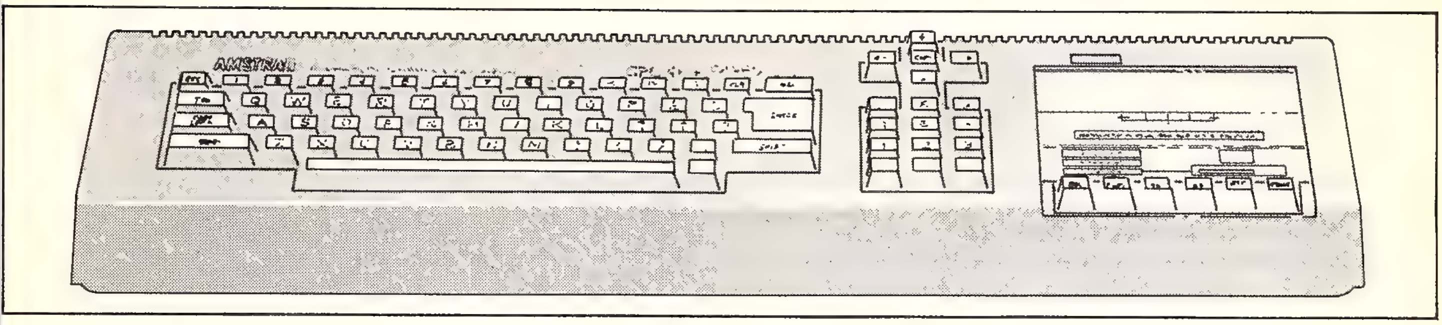


Amstrad sounds off

On paper, Amstrad's CPC464 microcomputer scheduled for June introduction seems an ideal all rounder — cheap, fast, 64K ram, high-resolution graphics and with a colour or monochrome monitor included in the price. Of interest to we of technical bent there's the promise of even more, including full access to the 4MHz Z80 processor, CP/M, Basic interrupt operations, assemblers and disassemblers.

With built in cassette recorder and direct-drive green-tube monitor the basic version costs £229, and for a further £100 one can have the colour-monitor version. Monitors will not be available separately. Disc-based monochrome and colour-monitor versions will cost £429 and £529 respectively including CP/M and Logo (a US import language for educational programs). The Japanese Hitachi format (IBM data format) 3in disc drives should be available separately for around £200. There is as yet no CP/M compatible software on 3in disc.

At these prices one couldn't buy the parts and build one cheaper. Assuming no hidden snags, the only remaining question is reliability. Bill Poel, general manager of Amstrad's new software company Amsoft and co-founder of Ambit International (recently sold to Bulgin), told *E&WW* "Amstrad has increased reliability of its products over the years and will continue doing so. We expect a 2 or 3% return rate — the biggest problem will probably be with people who haven't read the instructions properly and those who spill tea in the cassette mechanism".

Main i.cs used are the 6845 c.r.t. controller for 80-column text and up to 640 by 200 picture elements, an 8912 three-channel sound generator and an 8255 parallel i/o device. Screen memory is 16K. There is a Centronics parallel printer output and an expansion port but regrettably the connectors are the edge of the p.c.b. and not gold plated.

The keyboard and its separate numeric and cursor-control pad is full size and uses familiar keytops but has a membrane switch matrix underneath to keep costs down. Matsushita membrane technology is used, conductive rubber against gold-plated p.c.b. contact areas so, theoretically at least, it should last a long time.

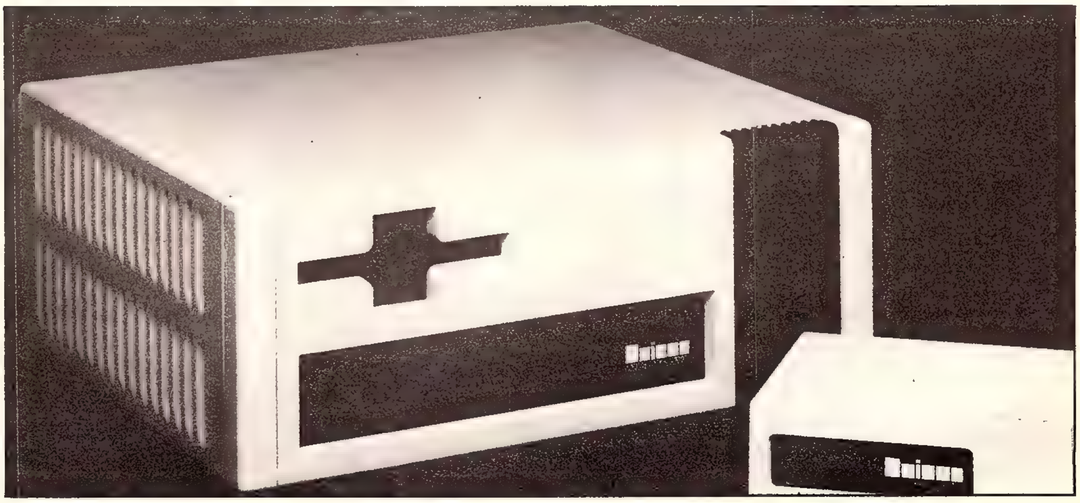
Considering that the average consumer is now wary of microcomputer manufacturers who promote products using predictions made by design engineers, Amstrad would be risking too much to promise all this but to present only part of it, especially when one takes into account Britain's current aggressive home microcomputer market. Delays in the introduction date could be devastating. The company expects to produce 200 000 units this year and sell them mainly through Dixons, Boots, Comet and Rumbelows. Amstrad Consumer Electronics plc, Brentwood House, 169 Kings Road, Brentwood, Essex CM14 4GF.

EWW 208

COMMUNICATIONS PROCESSOR TO EASE NETWORKING

Instead of employing separate communications devices, protocol converters, data concentrators, multiplexers, cluster controllers, packet processors, or nodal processors, the Netway communications system from Scicon combines all these functions into a single unit. The system can be configured to connect virtually any type of microcomputer, terminal, wordprocessor, and local-area network with host computers from IBM, ICL, DEC and Burroughs. Subsequent additions of dissimilar equipment to the network can be accommodated by upgrades to the disc-held software.

Netway has multiple distributed microprocessors within its hardware structure which has been optimised for communications. It uses a dynamic multi-tasking, multi-programming operating system called NCOS. The central unit of the system, Netway 200 with its 800Kbyte disc drive can be configured, on-line if necessary, to support local or remote microcomputers and other devices using the protocols of the host mainframe. Netway 200s works in conjunction with Netway 100s which interface individual devices into the network, and with the Netway 150 which provides remote connection to Netway local networks. The full capacity of the system is a large multi-node network incorporating up to 254 Netway processors each having a combination of up to 32 workstations and host ports, though the system can start by serving just one or a few workstations. Scicon Ltd, 49 Berners Street, London W1P 4AQ.
EWW 209



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BUHLER 69.11.22. 8-16 v DC micro miniature reversible fan. Uses a brushless servo motor for extremely high air flow, almost silent running and guaranteed 10,000 hr life. Measures only 62 x 62 x 22 mm. Current cost £32.00. **OUR PRICE ONLY £12.95 complete with data.**

MUFFIN-CENTAUR standard 4" x 4" x 1.25" fan supplied tested EX EQUIPMENT 240 v at £6.25 or 110 v at £4.95 or BRAND NEW 240 v at £10.50. 1000's of other fans Ex Stock. Call for Details. Post & Packing on all fans £1.60

SAVE £250
ONLY £199

SUPER PRINTER SCOOP

BRAND NEW CENTRONICS 739-2

The "Do Everything Printer" at a price that will **NEVER** be repeated. Standard **CENTRONICS** parallel interface for direct connection to **BBC, ORIC, DRAGON** etc. Superb print quality with full pin addressable graphics and 4 type fonts plus **HIGH DEFINITION** internal **PROPORTIONAL SPACED MODE** for **WORD PROCESSOR** applications. 80-132 columns, single sheet, sprocket or roll paper handling plus much more. Available **ONLY** from **DISPLAY ELECTRONICS** at the ridiculous price of ***ONLY £199.00*** + VAT Complete with full manual etc. Limited quantity –Hurry while stocks last.

Options. Interface cable (specify) for BBC, ORIC, DRAGON or CENTRONICS 36 way plg £12.50. Spare ribbon £3.00 each. BBC graphics screen dump utility program £8.50. Carriage and Ins. £10.00 + VAT

VIDEO MONITORS

5" CASED Superb little unit made by **HITACHI** in ergonimcally designed free standing case. Very high definition will display small but readable 132 columns wide! 12v DC opp. @ 800 ma, so ideal for mobile use. Supplied in AS NEW condition complete with data. Composite 75 ohm vid inp. Black & White CRT ***£45.00*** or Green CRT ***£55.00*** Carr & Ins £5.00.

12" CASED. Made by the British KGM Co. Designed for continuous use as a data display station, unit is totally housed in an attractive brushed aluminium case with ON-OFF, BRIGHTNESS and CONTRAST controls mounted to one side. Much attention was given to construction and reliability of this unit with features such as, internal transformer isolated regulated DC supply, all components mounted on two fibre glass PCB boards – which hinge out for ease of service, many internal controls for linearity etc. The monitor accepts standard 75 ohm composite video signal via SO239 socket on rear panel. Bandwidth of the unit is estimated around 20 Mhz and will display most high def graphics and 132 x 24 lines. Units are secondhand and may have screen burns. However where burns exist they are only apparent when monitor is switched off. Although unguaranteed all monitors are tested prior to despatch. Dimensions approx. 14" high x 14" wide by 11" deep. Supplied complete with circuit. 240 volt AC operation. ***ONLY £45.00 PLUS £9.50 CARR.***

24" CASED. Again made by the KGM Co with a similar spec as the 12" monitor Originally used for large screen data display. Very compact unit in lightweight alloy case dim. 19" H x 17" D x 22" W. All silicon electronics and composite video input make an ideal unit for schools, clubs, shops etc. Supplied in a used but working condition.

ONLY £55.00 PLUS £9.50 CARR & INS.

EPROM COPIERS

The amazing **SOFTY 2**. The 'Complete Toolkit' for writing, copying, modifying, and listing EPROMS of the 2516, 2716, 2532, 2732 range. Many other functions include integral keyboard, cassette interface, serial and parallel data i/o, UHF modulator.
ONLY £169.00 + PP £2.50

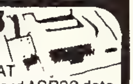
NEW 'GANG OF EIGHT' intelligent Z80 controlled gang bang programmer for ALL single 5V rail EPROMS. Copies up to 8, 27128 in typ. **ONLY 2 MINUTES!!** Internal LCD display and checking routines for **IDIOT PROOF** operation. **ONLY £395.00 + PP £3.00**

Data sheets on request.

GE TERMIPRINTER

A massive purchase of these desk top printer -terminals enables us to offer you these quality 30 cps printers at a **SUPER LOW PRICE** against their original cost of over £1000. Unit comprises of full QWERTY, electronic keyboard and printer mech with print face similar to correspondence quality typewriter. Variable forms tractor unit enables full width – up to 13.5" 120 column paper, upper – lower case, standard RS232 serial interface, internal vertical and horizontal tab settings, standard ribbon adjustable baud rates, quiet operation plus many other features. Supplied complete with manual. Guaranteed working ***£130.00*** or untested ***£85.00***, optional floor stand £12.50 Carr & Ins £10.00.

TELETYPE ASR33 I/O TERMINALS



FROM £195 + CAR. + VAT

Fully fledged industry standard ASR33 data terminal. Many features including ASCII keyboard and printer for data I/O auto data detect circuitry. RS232 serial interface. 110 baud, 8 bit paper tape punch and reader for off line data preparation and ridiculously cheap and reliable data storage. Supplied in good condition and in working order

Options: Floor stand ***£12.50*** + VAT
KSR33 with 20ma loop interface ***£125.00*** +
Sound proof enclosure ***£25.00*** + VAT

PROFESSIONAL KEYBOARD OFFER

An advantageous purchase of brand new surplus allows a great **QWERTY**, full travel, chassis keyboard offer at fractions of their original costs.

ALPHAMERIC 7204/60 full **ASCII** 60 key, upper, lower + control key, parallel TTL output plus strobe. Dim 12" x 6" +5 & −12 DC. ***£39.50.***

DEC LA34 Uncoded keyboard with 67 quality, **GOLD**, normally open switches on standard X, Y matrix. Complete with 3 LED indicators & i/o cable – ideal micro conversions etc. pcb DIM 15" x 4.5" ***£24.95*** Carriage on keyboards £3.00.

COLOUR MONITORS

NOVEX NC-1414-CL. Fully cased brand new 14" colour monitor. Many exacting features such as **RGB TTL** and **PAL** composite video inputs, Internal speaker and audio amp, **"GREEN TEXT"** switch for high def text applications and matching **BBC** colour scheme make this monitor ideal for the most exacting user. Brand new and Fully Guaranteed only **£199.00 + £10.00 carr.**

DATA MODEMS

Join the communications revolution with our range of EX TELECOM data modems. Made to most stringent spec and designed to operate for 24 hrs per day Units are made to the CCITT tone spec. With RS232 i/o levels via a 25 way 'D' skt. Units are sold in a tested and working condition with data. Permission may be required for connection to PO lines.

MODEM 2B "Hackers Special" fully fledged up to 300 baud full duplex, **ANSWER** or **CALL** modes. **AUTO ANSWER.** Data i/o via standard **RS232** 25 way 'D' socket. Just 2 wire connection to comms line. Ideal networks etc. Complete with data, tested, ready to run at a **NEW SUPER LOW PRICE** of ***ONLY £65.00*** + VAT + Carr.

MODEM 20-1 Compact unit for use with **MICRONET, PRESTEL** or **TELECOM GOLD** etc 2 wire direct connect 75 baud transmit 1200 baud receive Data i/o via RS232 D socket Guaranteed working with data ***£49.95***

MODEM 20-2 same as 20-1 but 75 baud receive 1200 baud transmit ***£130.00***

TRANSDATA 307A 300 baud acoustic coupler RS232 i/o **£95.00**

NEW DSL2123 Multi Standard modem selectable V21 300-300 bps, V23 75-1200, V23 1200-75 full duplex. Or 1200-1200 half duplex modes. Full auto answer via modem or CPU. LED status indicators. CALL or ANS modes Switchable **CCITT** or **BELL 103 & 202**. Housed in ABS case size only 2.5" x 8.5" x 9". *£286.00* + VAT

For further data or details on other EX STOCK modems contact sales office.

Carriage on all modems £10.00 + VAT.

SUPER DEAL? NO — SUPER STEAL!!

The FABULOUS 25CPS TEC Starwriter

BRAND NEW AT ONLY £499 + VAT

Save over £400
a fraction of its original cost.

Made to the very highest spec the **TEC Starwriter FP1500-25** features a heavy duty die cast chassis and DIABLO type print mechanism giving superb registration and print quality Microprocessor electronics offer full DIABLO/QUME command compatability and full control via CPM Wordstar etc. Many other features include bi directional printing, switchable 10 or 12 pitch, full width 381 mm paper handling with upto 163 characters per line, friction feed rollers for single sheet or continuous paper, internal buffer, standard RS232 serial interface with handshake Supplied absolutly **BRAND NEW** with 90 day guarantee and **FREE** daisy wheel and dust cover Order **NOW** or contact sales office for more information Optional extras: RS232 data cable **£10.00.** Tech manual **£7.50** Tractor feed **£140.00.** Spare daisy wheel **£3.00** Carriage & Ins. (UK Mainland) **£10.00.**

66% DISCOUNT

ELECTRONIC COMPONENTS EQUIPMENT

Due to our massive bulk purchasing programme which enables us to bring you the best possible bargains, we have thousands of I C s, Transistors, Relays, Cap s, P C B s Sub-assemblies, Switches, etc etc surplus to our requirements Because we don t have sufficient stocks of any one item to include in our ads. we are packing all these items into the *BARGAIN PARCEL OF A LIFETIME* Thousands of components at giveaway prices! Guaranteed to be worth at least *3 times* what you pay Unbeatable value!! Sold by weight

2.5kls ***£4.25*** + pp £1.25 5kls ***£5.90*** + £1.80
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SEMICONDUCTOR 'GRAB BAGS'

Mixed Semis amazing value contents include transistors, digital, linear, I.C.'s triacs, diodes, bridge recs., etc. etc. All devices guaranteed brand new full spec. with manufacturer's markings, fully guaranteed, 50+ ***£2.95*** 100+ ***£5.15.***

TTL 74 Series A gigantic purchase of an "across the board" range of 74 TTL series I.C.'s enables us to offer 100+ mixed "mostly TTL" grab bags at a price which two or three chips in the bag would nnormally cost to buy. Fully guaranteed all I.C.'s full spec 100+ ***£6.90*** 200+ ***£12.30*** 300+ ***£19.50***

DEC CORNER

MOSTEK CRT 80E Brand new dual eurocard, Z80 based VT100 PLUS emulator with graphics etc	***£499.00***
BA11-MB 3.5" Box, PSU, LTC	***£385.00***
DLV11-J 4 x EIA interface	***£310.00***
RK05-J 2.5 Mb disk drives	***£650.00***
PDP1105 Cpu, Ram, i/o, etc.	***£450.00***
RT11 ver. 3B doc kit	***£70.00***
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DILOG DQ100 RK05 LSI 4 x RK05 disk controller	***£450.00***
MSC4804 (Equiv MSV11-L) 256k bytes ram card	***£499.00***
LAX34-AL LA34 tractor feed	***£85.00***

1000's of EX STOCK spares for **DEC PDP8 PDP11 PDP15** & periperhals. Call for details. All types of Computer equipment and spares wanted for prompt **CASH PAYMENT**

ALL PRICES PLUS VAT

All prices quoted are for U.K Mainland, paid cash with order in Pounds Stirling PLUS VAT. Minimum order value ***£2.00***, Minimum Credit Card order ***£10.00***. Minimum BONA FIDE account orders from Government depts., Schools, Universities and established companies ***£20.00*** Where post and packing not indicated please ADD £1.00. **+ VAT** Warehouse open Mon-Fri 9.30 – 5.30. Sat. 10.15 – 5.30. We reserve the right to change prices and specifications without notice. Trade, Bulk and Export enquiries welcome.

DISPLAY -ELECTRONICS-

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WELL WORTH A SECOND LOOK...

NEW!!

No – you're not seeing double, just the Crotech 3132's Component Comparator in action. This unique feature, using two Crotech component testers, gives you the benefit of checking an active or passive component against a known standard. Complete circuits can also be checked using signature techniques.

But that's not the only new feature. The 3132 has three DC source outlets available on the front panel, capable of powering most solid state circuits. Dare we say that the 3132 is the nearest affordable 'scope to come near to being a complete test system?

14 Trigger Functions
Triggering up to 40MHz

Add & Subtract

X–Y Mode

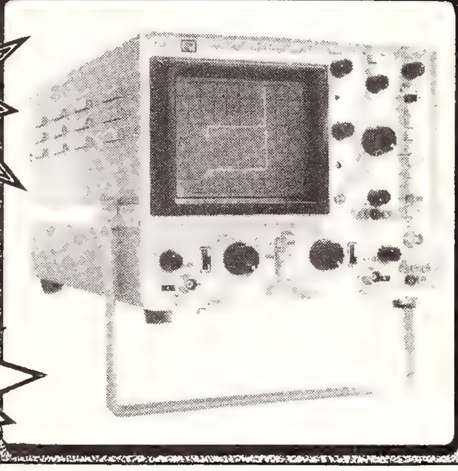
DC – 20MHz

PLUS

COMPONENT COMPARATOR and DC SOURCE OUTLETS

40ns – 0.2s/div

2mV/div



Crotech Instruments Limited
2 Stephenson Road, St. Ives, Huntingdon, Cambs. PE17 4WJ
Telephone: (0480) 301818

For full data sheet and a copy of our Highlight brochure — all free — just give us a call or fill in the enquiry card

CIRCLE 41 FOR FURTHER DETAILS.

SPECIAL OFFER from ELECTRONICS & Wireless World

HIGH QUALITY PRECISION PLIERS AND CUTTERS

These precision box jointed pliers and cutters are manufactured in West Germany and are of extremely high quality. They are supplied to and used by the electronics industry. They all have double leaf springs, moulded-on PVC grips and polished heads. The cutters have induction hardened cutting edges.

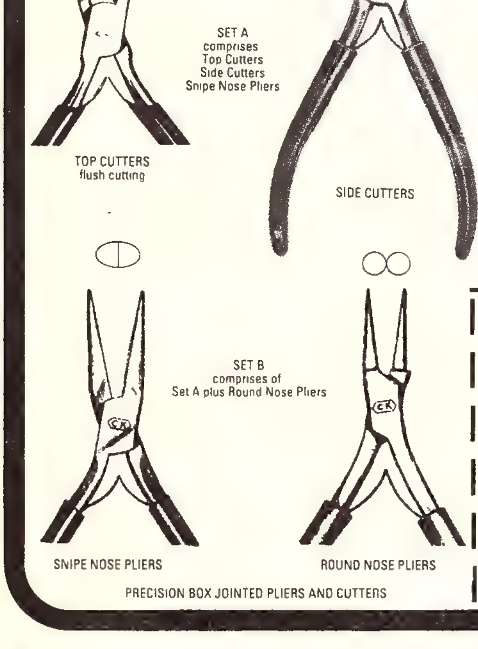
As a little test of the quality and the squareness and fit of the jaws we tried holding pieces of paper with the pliers and cutting the paper with the cutters – we were extremely impressed. Naturally we also tested them with wire and were equally pleased with the results.

We decided to offer readers the alternative of a set of the three most vital tools, comprising top cutters, side cutters and snipe nose pliers (smooth inside jaws). All are approximately 4¾" long. In shops this set (Set A) would cost about £29.70, but our price to readers is **£19.50** incl VAT and UK p&p.

Our alternative choice is the above set plus a pair of round nose pliers which are extremely useful for shaping wires, etc. This set (Set B) comprising the four tools would normally cost £38 but we are offering it at only **£24.75** incl VAT and UK p&p.

We regret the tools are not available separately – only the sets as offered.

To order either of the above, use coupon or photocopy or on plain paper and send with crossed cheque/PO made out to Wireless World Offers. Send to Pliers Offer, 48 Beauchamp Place, London SW3 1NX. Allow up to 28 days for delivery, UK addresses only. Closing date July 31st 1984. VAT receipt will be supplied if SAE is enclosed with order.



PRECISION BOX JOINTED PLIERS AND CUTTERS

Coupon to Wireless World Pliers Offer, 48 Beauchamp Place, London SW3 1NX

Please send me:

............Pliers/Cutters Sets
............Set A at £19.50
............Set B at £24.75
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for which I enclose total £..................................

NAME ....
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Price includes postage, packing and VAT. Offer applies to UK only. Please allow 28 days for delivery. Registered No. 151537. Reg. Office: Quadrant House, Sutton, Surrey SM2 5AS. 83/199

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AA119	0.10
AAY30	0.17
AAY30	0.17
AAZ13	0.15
AAZ15	0.15
AAZ17	0.15
AC107	0.55
AC125	0.25
AC126	0.25
AC127	0.25
AC128	0.30
AC141	0.28
AC141K	0.35
AC142	0.28
AC142K	0.35
AC176	0.30
AC187	0.28
AC188	0.28
ACY17	1.30
ACY18	1.15
ACY19	1.10
ACY20	1.10
ACY21	1.15
ACY39	2.50
AD149	0.75
AD161	0.35
AD162	0.35
AF106	0.35
AF114	0.75
AF115	0.75
AF116	0.75
AF117	0.75
AF139	0.33
AF186	1.00
AF239	0.39
AFZ11	4.00
AFZ12	4.00
ASY26	1.40
ASY27	0.90

ASZ15	1.20
ASZ16	1.10
ASZ17	1.00
ASZ20	2.30
ASZ21	2.50
AU113	2.50
AUY10	3.00
BA145	0.13
BA148	0.15
BA154	0.10
BA155	0.11
BA156	0.10
BAW62	0.05
BAX13	0.06
BAX16	0.06
BC107	0.16
BC108	0.16
BC109	0.16
BC113	0.15
BC114	0.15
BC115	0.18
BC116	0.19
BC117	0.23
BC118	0.18
BC125	0.18
BC126	0.18
BC135	0.15
BC136	0.19
BC137	0.19
BC147	0.12
BC148	0.12
BC149	0.13
BC157	0.13
BC158	0.13
BC159	0.13
BC167	0.11
BC170	0.11
BC171	0.11
BC172	0.11

BC173	0.11
BC177	0.28
BC178	0.28
BC179	0.28
BC182	0.11
BC183	0.11
BC184	0.11
BC212	0.11
BC213	0.11
BC214	0.11
BC237	0.11
BC238	0.11
BC301	0.33
BC303	0.34
BC307	0.11
BC308	0.11
BC327	0.12
BC328	0.12
BC337	0.12
BC338	0.12
BCY30	1.25
BCY31	1.50
BCY32	1.50
BCY33	1.10
BCY34	1.00
BCY39	3.40
BCY40	2.80
BCY42	0.30
BCY43	0.30
BCY58	0.19
BCY70	0.17
BCY71	0.18
BCY72	0.17
BCZ11	1.75
BD115	0.42
BD121	1.70
BD123	2.80
BD124	2.00
BD131	0.44

BD132	0.48
BD135	0.40
BD136	0.40
BD137	0.40
BD138	0.48
BD139	0.48
BD140	0.50
BD144	2.00
BD181	1.20
BD183	0.80
BD2137	0.54
BD238	0.54
BDX10	0.91
BDX32	2.00
BDY20	1.50
BDY60	2.75
BF115	0.35
BF152	0.16
BF153	0.16
BF154	0.17
BF159	0.17
BF160	0.17
BF167	0.24
BF173	0.30
BF177	0.35
BF178	0.35
BF179	0.35
BF180	0.28
BF181	0.28
BF182	0.30
BF183	0.28
BF184	0.28
BF185	0.30
BF194	0.14
BF195	0.12
BF196	0.13
BF197	0.14
BF200	0.40
BF224	0.25
BF244	0.28

BF257	0.27
BF258	0.27
BF259	0.28
BF336	0.34
BF337	0.33
BF338	0.36
BFS21	4.00
BFS28	2.25
BFS61	0.20
BFS98	0.20
BFW10	0.97
BFW11	0.96
BFX84	0.30
BFX85	0.30
BFX87	0.30
BFX88	0.30
BFY50	0.25
BFY51	0.25
BFY52	0.25
BFY64	0.30
BFY90	0.95
BSX19	0.27
BSX20	0.27
BSX21	0.29
BT106	1.20
BTY79/400R	2.00
BU205	1.30
BU206	1.50
BU208	2.00
BY100	0.40
BY126	0.13
BY127	0.14
BZX61	0.17
Series	
BZY88	0.10
Series	
CRS1/40	0.60
CRS3/40	0.75
CRS3/60	0.90
GEX66	3.00

GEX541	5.00
GJ3M	1.50
GM0378A	1.75
KS100A	0.45
MJE340	0.60
MJE370	0.73
MJE371	0.71
MJE520	0.47
MJE521	0.73
MJE2955	1.30
MJE3055	1.10
MPF102	0.35
MPF103	0.35
MPF104	0.35
MPF105	0.35
MPSA06	0.26
MPSA56	0.28
MPSU01	0.53
MPSU06	0.65
MPSU56	0.69
NE555	0.45
NKT401	3.50
NKT403	2.50
NKT404	2.20
OA5	1.20
OA7	0.60
OA10	0.55
OA47	0.12
OA70	0.25
OA79	0.12
OA81	0.17
OA85	0.17
OA90	0.08
OA91	0.08
OA95	0.08
OA200	0.15
OA202	0.15
OA211	1.50
OAZ200	1.50
OAZ201	1.50
OAZ206	1.50

OAZ207	1.50
OC16	2.50
OC20	2.50
OC22	2.50
OC23	4.00
OC24	3.00
OC25	1.00
OC26	1.50
OC28	2.00
OC29	2.00
OC35	1.50
OC36	1.50
OC41	0.90
OC42	0.90
OC43	1.50
OC44	0.85
OC45	0.65
OC71	0.55
OC72	1.00
OC73	1.00
OC74	0.70
OC75	0.65
OC76	1.00
OC77	1.00
OC81	0.65
OC81Z	1.20
OC82	0.90
OC83	1.00
OC84	0.80
OC122	2.75
OC123	2.00
OC139	3.00
OC140	4.00
OC141	4.25
OC170	1.25
OC171	1.25
OC200	1.50
OC201	2.50
OC202	2.75
OC203	3.00
OC204	3.00

OC205	2.75
OC206	2.75
OC207	2.50
OCP71	2.00
ORP12	1.00
R2008B	2.00
R2009	2.25
R2010B	2.00
T1C44	0.27
T1C226D	1.20
T1L209	0.16
T1P29A	0.43
T1P30A	0.45
T1P31A	0.33
T1P32A	0.36
T1P33A	0.54
T1P34A	0.67
T1P41A	0.44
T1P42A	0.42
T1P2955	0.70
T1P3055	0.56
T1S43	0.43
ZS140	0.25
ZS170	0.21
ZS178	0.54
ZS271	0.23
ZS278	0.57
ZTX107	0.12
ZTX108	0.12
ZTX109	0.12
ZTX300	0.13
ZTX301	0.14
ZTX302	0.18
ZTX303	0.18
ZTX304	0.20
ZTX311	0.13
ZTX314	0.25
ZTX500	0.14
ZTX501	0.14
ZTX502	0.18
ZTX503	0.19

ZTX504	0.21
ZTX531	0.24
ZTX550	0.25
1N914	0.05
1N916	0.09
1N4001	0.06
1N4002	0.06
1N4003	0.06
1N4004	0.07
1N4005	0.09
1N4006	0.11
1N4007	0.12
1N4009	0.07
1N4148	0.04
1N5400	0.13
1N5401	0.13
1S44	0.04
1S920	0.08
1S921	0.09
2G301	1.00
2G302	1.00
2G306	1.00
2N404	1.30
2N696	0.32
2N697	0.32
2N698	0.32
2N705	1.25
2N706	0.25
2N708	0.25
2N930	0.25
2N1131	0.30
2N1132	0.30
2N1302	1.20
2N1303	0.80
2N1304	1.20
2N1305	1.00
2N1306	1.50
2N1307	1.10
2N1308	1.75
2N1309	1.20
2N1613	0.32

2N1671	5.00
2N1893	0.32
2N2147	4.00
2N2148	3.75
2N2218	0.32
2N2219	0.32
2N2220	0.20
2N2221	0.20
2N2222	0.20
2N2223	4.25
2N2368	0.25
2N2369A	0.25
2N2484	0.25
2N2646	0.50
2N2904	0.32
2N2905	0.32
2N2906	0.21
2N2907	0.21
2N2924	0.26
2N2925	0.22
2N2926	0.15
2N3053	0.26
2N3054	0.55
2N3055	0.65
2N3440	0.70
2N3441	0.85
2N3442	1.25
2N3614	2.20
2N3702	0.11
2N3703	0.11
2N3704	0.11
2N3705	0.11
2N3706	0.11
2N3707	0.11
2N3708	0.10
2N3709	0.11
2N3710	0.10
2N3711	0.10
2N3771	1.40
2N3772	1.60
2N3773	1.80

2N3819	0.30
2N3820	0.39
2N3823	0.60
2N3866	1.00
2N3904	0.17
2N3905	0.17
2N3906	0.17
2N4058	0.20
2N4059	0.20
2N4060	0.16
2N4061	0.16
2N4062	0.16
2N4124	0.16
2N4126	0.16
2N4286	0.15
2N4288	0.18
2N4289	0.18
2N4400	0.11
2N4401	0.11
2N4402	0.11
2N5457	0.32
2N5458	0.32
2N5459	0.32
2S017	10.00
2S019	12.00
2S026	25.00
2S103	1.50
2S302	2.00
2S303	1.50
2S322	3.50
2S324	3.50
2S701	2.00
2S745A	0.95
2S746A	0.95

CV Devices
Large stocks
Prices on
application

VALVES

A1834	9.00
A2087	13.50
A2134	17.50
A2293	16.00
A2426	27.50
A2521	25.00
A2900	15.00
A3343	45.00
AZ31	2.75
AZ41	2.60
BK448	114.90
BK484	155.35
BS90	58.00
BS810	60.00
BT5	58.95
BT17	151.00
BT19	44.05
BT29	349.15
BT69	354.80
BT95	129.90
CBL31	4.00
CL33	4.00
CY31	3.00
C1K	20.00
C3A	22.00
C3JA	22.00
DA41	25.00
DA42	18.70
DAF91	1.75
DAF96	1.75
DET22	35.00
DET24	49.00
DF91	1.75
DF96	1.75
DK91	1.75
DK92	2.00
DK96	1.75
DL92	2.00
DL94	1.75
DL96	1.75
DLS10	14.00
DLS15	12.50
DLS16	12.50
DLS19	12.50
DM70	2.00
DM71	2.00
DM160	4.75
DY87	1.50
DY802	1.50
E55L	45.00
E80CC	8.81
E80CF	11.27
E80F	14.19
E80L	13.73
E81CC	8.00
E81L	13.27
E82CC	8.10
E83CC	8.40
E86C	8.25
E88C	8.25
E88CC	8.42
E90CC	9.47
E90F	9.90
E91H	6.25
E92CC	8.75
E99F	9.10

E130L	18.50
E180CC	10.50
E180F	10.20
E182CC	13.25
E186F	11.50
E188CC	8.91
E280F	22.51
E283CC	12.00
E288CC	17.50
EA52	32.25
EA76	2.50
EABC80	1.25
EAC91	3.50
EAF42	2.50
EAF801	2.00
EB41	4.00
EB91	1.50
EBC33	2.50
EBC41	2.50
EBC81	1.50
EBC90	1.25
EBF80	1.50
EBF83	1.75
EBF89	1.50
EBL31	4.00
EC90	1.25
EC91	8.00
EC92	1.75
EC157	380.00
ECC33	4.50
ECC35	4.50
ECC40	4.50
ECC81	1.75
ECC82	1.75
ECC83	1.75
ECC84	1.75
ECC85	1.75
ECC86	2.50
ECC88	2.10
ECC89	2.00
ECC91	8.93
ECC189	2.10
ECC807	1.75
ECC808	3.00
ECF80	1.55
ECF82	1.50
ECF86	2.50
ECH35	3.00
ECH42	3.50
ECH81	3.00
ECH83	2.50
ECH84	2.50
ECL80	1.50
ECL81	1.75
ECL82	1.50
ECL83	3.00
ECL84	1.50
ECL85	1.50
ECL86	1.75
EF37A	5.00
EF39	2.75
EF40	5.00
EF41	3.50
EF42	4.50
EF50	2.50
EF54	5.00
EF55	3.50
EF80	1.75
EF83	4.00

EF85	1.75
EF86	1.75
EF89	2.50
EF91	2.95
EF92	6.37
EF93	1.50
EF94	2.50
EF95	5.99
EF98	2.00
EF183	2.00
EF184	2.00
EF804S	12.00
EF805S	15.00
EH90	1.75
EK90	1.50
EL32	2.50
EL33	4.00
EL34MUI	4.00
EL36	2.50
EL41	2.80
EL42	2.50
EL81	5.25
EL83	6.00
EL84	2.25
EL86	2.75
EL90	2.25
EL91	9.69
EL95	2.00
EL156	30.00
EL360	8.50
EL500/504	3.00
EL509	7.00
EL821	13.00
EL822	13.97
EM34	5.00
EM80	2.50
EM81	2.50
EM84	2.00
EM85	2.75
EM87	2.50
EN32	17.46
EN91	£7.05
EN92	6.96
EY51	2.75
EY81	2.50
EY83	2.50
EY84	9.24
EY86	1.75
EY88	1.75
EY500A	3.00
EY802	1.75
EZ35	1.75
EZ40	2.50
EZ41	2.50
EZ80	1.50
EZ81	1.50
EZ90	2.00
FW4-500	3.50
FW4-800	3.50
G1.371K	35.00
G551K	12.00
G180.2M	17.50
G240.2D	12.00
G400.1K	17.50
GN4	9.00
GN4A	9.00
GS16	16.00
GT1C	15.00
GU50	20.00

GU51	20.00
GXU1	15.35
GXU2	30.00
GXU3	25.40
GXU4	44.50
GXU50	20.00
GY501	3.00
GZ32	4.00
GZ33	4.75
GZ34	3.00
GZ37	4.75
KT61	5.00
KT66	12.00
KT77 Gold Lion	9.00
KT88	15.00
KTW61	2.50
KTW62	2.50
KTW63	2.50
M8079	12.34
M8080	8.25
M8081	9.82
M8082	9.69
M8083	8.58
M8091	10.43
M8096	6.80
M8097	8.10
M8098	6.15
M8099	8.00
M8100	9.52
M8136	10.23
M8137	10.23
M8140	6.00
M8141	6.50
M8142	8.75
M8144	7.50
M8149	6.50
M8161	9.35
M8162	10.40
M8163	8.25
M8190	5.00
M8195	10.85
M8196	7.50
M8204	7.05
M8212	11.37
M8223	6.00
M8224	6.30
M8225	4.50
M8248	14.03
MD2901	115.00
MU14	2.50
MX119	55.00
MX123	72.00
MX145	56.70
MX151	17.25
MX152	131.25
MX161	152.25
MX163	20.25
MX164	25.52
MX166	147.00
MX168	50.00
N78	15.00
OA2	3.25
OA3	2.50
OA4	6.00
OB2	4.35
OB3	2.50
OC2	4.35
OC3	2.50

OD3	2.50
OZ4	3.50
PC86	2.50
PC88	2.50
PC95	1.75
PC97	1.75
PC900	1.75
PCC84	1.50
PCC85	1.50
PCC88	2.00
PCC89	1.75
PCC189	2.50
PCC805	1.60
PCC806	1.60
PCE82	2.00
PCF80	2.00
PCF82	1.50
PCF86	2.50
PCF87	2.00
PCF200	3.25
PCF201	3.25
PCF801	2.50
PCF802	2.50
PCF805	1.70
PCF806	1.70
PCF808	1.70
PCL82	2.00
PCL83	3.00
PCL84	2.00
PCL85	2.50
PCL86	2.50
PCL805/85	2.50
PD500	6.00
PE06-40N	45.00
PFL200	2.50
PL36	2.50
PL81	1.75
PL81A	2.00
PL82	1.50
PL83	2.50
PL84	2.00
PL504/5	2.50
PL508	2.50
PL509	6.00
PL519	6.00
PL801	1.50
PL802	6.00
PY33	2.50
PY81	1.50
PY82	1.50
PY83	2.50
PY88	2.00
PY500A	4.00
PY800	1.50
PY801	1.50
QF451	82.50
QQV02-6	30.50
QQV03-10	20.50
QQV03-20A	48.38
QQV06-40A	65.34
QQV07-50	68.60
QQZ06-40A	62.20
QU37	12.50
QV03-12	6.80
QV04-7	3.50
QV08-100	155.70

QY3-65	59.86
QY3-125	66.50
QY4-250	68.00
QY4-400	74.20
QY5-500	175.00
QY5-3000A	420.00
QZ06-20	32.70
R10	6.00
R17	3.00
R18	3.00
R19	9.24
R20	2.50
RG3-250	32.68
RG3-250A	32.68
RG3-1250	59.50
RG4-1250	61.60
RG4-3000	99.45
RR3-250	40.00
RR3-1250	45.75
S11E12	65.00
S130	6.00
S130P	6.00
STV280-40	14.00
STV280-80	21.00
SU41	5.00
SU42	10.00
TD03-10	35.00
TD03-10F	35.00
TT15	50.00
TT21	30.00
TT22	37.50
TT100	60.00
TY2-125	65.00
TY4-400	75.00
TY4-500	98.35
TY5-500	201.50
TY6-800	196.50
TY6-5000A	490.00
TY6-5000B	395.00
TY6-5000W	407.00
TY7-6000A	485.00
TY7-6000W	303.60
TZ40	25.00
U18-20	3.50
U19	13.75
U25	2.50
U26	2.50
U37	12.00
UABC80	1.25
UAF42	2.50
UB41	3.00
UBC41	2.25
UBF89	1.50
UCC84	1.75
UCC85	1.85
UCF80	2.00
UCH42	2.50
UCH81	2.50
UCL82	1.75
UCL83	2.75

UF41	2.00
UF42	2.10
UF80	1.75
UF85	1.75
UF89	2.00
UL41	3.50
UL84	1.75
UM80	2.00
UY41	2.25
UY85	2.25
VLS631	15.00
XG1-2500	55.00
XG2-6400	141.90
XG5-500	26.60
XG2-6400	162.00
XR1-1600A	53.75
XR1-3200	81.97
XR1-3200A	
XR1-6400	102.00
YD1120	395.00
YD1240	450.00
Z759	25.00
ZM1000	8.00
ZM1001	8.00
ZM1020	9.00
ZM1021	9.00
ZM1022	9.00
ZM1023	9.00
ZM1040	19.36
ZM1041	16.66
ZM1042	17.77
1B3GT	3.00
1B24	25.00
1B35A	48.00
1B63	64.00
1R5	1.75
1S5	1.75
1T4	1.75
2AS15	11.50
2C39A	60.00
2C43	70.00
2D21	3.25
2E26	8.25
2J42	98.00
2J55	175.00
2J70A	383.00
2J70B	336.00
2K25	125.00
3-400Z	85.00
3-500Z	85.00
3A5	3.00
3B24	11.00
3B28	15.35
3B29	20.05
3B240M	17.50
3B241M	17.50
3C23	25.00
3C45	24.50
3CX100A5	47.00
3E29	45.00
3S4	2.00
3V4	1.75
465A	60.00
4-125A	60.00

4-250A	80.00
4-400A	87.00
4B32	20.00
4C35	78.00
4CX250B	45.00
4CX350A	73.00
4X150A	60.00
4X150D	56.00
5B254M	35.00
5B255M	35.00
5C22	160.00
5J180E	1650.00
5R4GY	3.50
5U4G	3.00
5U4GB	2.50
5V4G	2.50
5Y3GT	2.50
5Z3	4.00
5Z4G	2.50
5Z4GT	2.50
6-30L2	1.75
6AB4	1.75
6AB7	3.00
6AC7	3.00
6AF4A	4.25
6AG7	3.00
6AH6	5.00
6AK5	5.99
6AK6	2.50
6AL5	1.50
6AM4	4.00
6AM5	9.69
6AM6	6.02
6AN5	4.75
6AN8A	3.50
6AQ5	2.25
6AS6	8.66
6AS7G	8.75
6AT6	1.25
6AU5GT	5.00
6AU6	2.50
6AV5GA	4.50
6AV6	1.50
6AX5GT	3.00
6B7	3.25
6B8	3.25
6BA6	1.50
6BA7	5.00
6BA8A	4.00
6BC4	4.00
6BE6	1.50
6BH6	2.50
6BJ6	2.25
6BK4	4.50
6BL6	85.00
6BL7GT	4.50
6BM6	115.00
6BN6	2.00
6BQ7A	3.50
6BR7	6.00
6BR8A	3.50
6BS7	6.00
6BW6	6.00
6BW7	1.50
6BX7GT	5.00
6BZ6	2.75
6C4	1.25
6CB6A	2.50
6CD6GA	5.00

6CG7	2.50
6CH6	13.00
6CL6	3.75
6CW4	8.00
6D2	1.50
6DK6	3.00
6DQ6B	4.75
6EA8	3.00
6EB8	2.50
6EW6	2.25
6F6	3.00
6F23	1.60
6F28	1.60
6F33	33.50
6H1	14.00
6H2N	2.75
6H3N	2.75
6H6	3.00
6J4	5.50
6J6	8.93
6J7	4.75
6K4N	2.50
6K6GT	2.75
6K7	3.00
6K8	3.00
6KD6	7.00
6L6G	3.00
6L6GA	3.00
6L6GC	3.00
6L6GT	3.00
6L7	2.50
6N2P	2.50
6N3P	2.50
6N7	3.00
6P25	4.00
6Q7	3.75
6R7	3.25
6SA7	3.00
6SC7	2.75
6SF7	2.50
6SH7	3.00
6SJ7	3.25
6SK7	3.50
6SK7GT	3.00
6SN7GT	3.00
6SQ7	3.40
6SR7	4.00
6SS7	2.75
6U5G	3.50
6U8A	2.25
6V6GT	2.25
6X4	2.00
6X5GT	1.75
7B7	2.50
7C5	4.00
7C6	2.50
7H7	4.00
7R7	4.25
7S7	3.50
7Y4	2.25
7Z4	2.00
11E3	55.00
12AH8	5.00
12AT6	1.50
12AT7	1.75
12AU6	2.50
12AU7	1.75
12AV6	2.50
12AV7	3.50

12AX7	1.75
12AY7A	4.00
12B4A	3.50
12BA6	2.50
12BE6	2.50
12BH7	2.75
12BY7	3.00
12E1	20.00
12E11TT	28.00
12E14	65.00
13E1	170.00
19H4	27.50
19H5	47.50
24B9	67.25
30C15	2.00
30C17	2.00
30C18	2.00
30F5	1.60
30FL1/2	1.38
30FL12	1.80
30FL14	2.00
30L1	1.50
30L15	2.00
30L17	2.00
30P4	2.50
30P19	2.50
30PL1	3.00
30PL14	1.80
30PL15	1.80
35W4	1.00
50C5	1.50
75B1	6.05
75C1	4.50
85A1	7.50
85A2	4.45
90AG	12.96
90AV	12.96
90C1	6.00
90CG	14.54
90CV	15.45
92AG	15.50
92AV	12.96
95A1	8.45
150B2	6.50
150B3	8.35
150C2	3.25
150C4	6.00
211	35.00
723AB	125.00
803	25.00
805	45.00
807	3.75
811A	18.33
812A	18.33
813	125.86
833A	193.16
866A	20.03
872A	20.00
922	6.00
931A	18.50
1624	4.00
1625	3.50
2050	7.50
4212E	300.00
4212H	300.00
5544	81.97
5545	102.00
5551A	114.90
5552A	155.35

5642	9.00
5654	3.00
5651	4.45
5670	4.50
5675	28.00
5687	6.00
5696	4.50
5718	7.50
5725	5.50
5726	11.37
5727	7.05
5749	2.50
5751	4.00
5763	4.50
5814A	4.00
5840	4.00
5842	12.00
5876A	31.50
5879	5.00
5886	15.00
5963	2.50
5965	3.50
6005	2.25
6021	4.50
6057	10.23
6058	12.34
6059	6.00
6061	6.00
6063	3.75
6064	8.58
6067	10.23
6072	6.00
6080	14.00
6097A	235.00
6097B	200.00
6146A	8.25
6146B	8.25
6159B	19.00
6189	9.50
6201	11.40
6442	20.00
6883B	8.25
6973	4.00
7025	3.00
7551	6.25
7586	12.00
7587	18.50
7609	56.00
7868	6.00
7895	12.00
8005	110.49
8068	14.00
8122	90.00
8136	2.50
8417	6.00
18042	11.53
18045	10.49

Tested
Ex-Equipment
4CX250B 6.50
CV Devices
Large stocks
Prices on
application

BASES

B7G unskirted	0.25
B7G skirted	0.35
B9A unskirted	0.25
B9A skirted	0.35
Int Octal	0.35
Loctal	0.55
Nuvistor base	2.00
8 pin DIL Texas	0.10
14 pin DIL Texas	0.10
16 pin DIL Texas	0.10
Valve screening cans all sizes	0.40

CRTs

2AP1	8.50
2BP1	9.00
3BP1	12.00
3DP1	5.00
3EG1	10.00
3FP7	6.00
3GP1	6.00
3JP1	8.00
3JP2	8.00
3JP7	10.00
3KP1	15.00
3RP1	35.00
3WP1	20.00

5ADP1	55.00
5CP1	10.00
5CP1A	40.00
5FP15A	15.00
5UP7	25.00
DG7-5	63.32
DG7-31	58.07
DG7-32	58.07
DG7-36	65.00
DH3-91	56.83
DH7-11	113.12
VCR97	12.00
VCR138	12.00
VCR138A	12.50
VCR139A	8.00

VCR517B	10.00
VCR517C	10.00

Tube Bases
Prices on
application

INTEGRATED CIRCUITS

7400	0.16
7401	0.17
7402	0.17
7403	0.17
7404	0.18
7405	0.18
7406	0.43
7407	0.43
7408	0.20
7409	0.20
7410	0.17
7412	0.29
7413	0.32
7416	0.32
7417	0.32
7420	0.18
7422	0.20

7423	0.33
7425	0.30
7427	0.30
7428	0.43
7430	0.17
7432	0.30
7433	0.40
7437	0.32
7438	0.32
7440	0.32
7441	0.90
7442	0.72
7447AN	1.17
7450	0.18
7451	0.18
7453	0.18
7454	0.18

7460	0.18
7470	0.38
7472	0.33
7473	0.38
7474	0.38
7475	0.54
7476	0.42
7480	0.56
7482	0.75
7483	1.00
7484	1.05
7486	0.39
7490	0.60
7491	0.82
7492	0.60
7493	0.60
7494	0.82

7495	0.73
7496	0.82
7497	3.15
74100	1.54
74107	0.45
74109	0.73
74110	0.51
74111	0.71
74116	1.85
74118	1.00
74119	1.54
74120	0.83
74121	0.43
74122	0.62
74123	1.18
74125	0.58
74126	0.58
74128	0.63
74132	0.72

74136	0.51
74141	0.89
74142	2.30
74143	2.60
74144	2.60
74145	1.00
74147	2.00
74148	1.76
74150	1.80
74151	0.94
74154	1.80
74155	0.90
74156	0.90
74157	0.75
74159	2.20
74170	2.40
74172	4.40
74173	1.42
74174	1.60

74175	1.02
74176	1.16
74178	1.36
74179	1.36
74180	1.20
74190	1.90
74191	1.90
74192	1.90
74193	1.90
74194	1.25
74195	1.20
74196	1.35
74197	1.35
74198	2.70
74199	2.30
TAA570	2.30
TAA630S	3.50
TAA700	3.90
TBA480Q	1.84

TBA520Q	2.30
TBA530	1.98
TBA540Q	2.30
TBA550Q	3.22
TBA560CQ	3.22
TBA673	2.20
TBA700	1.52
TBA720Q	2.30
TBA750Q	2.07
TBA800	1.20
TBA920	2.90
TBA920Q	2.90
TBA990Q	2.90
TCA270Q	2.90
TCA760A	1.38

Terms of business: CWO. Postage and packing valves and semiconductors 50p per order. CRTs £1.50. Prices excluding VAT, add 15%. Price ruling at time of despatch.
In some cases prices of Mullard and USA valves will be higher than those advertised. Prices correct when going to press.
Account facilities available to approved companies with minimum order charge £10. Carriage and packing £1.50 on credit orders.
Over 10,000 types of valves, tubes and semiconductors in stock. Quotations for any types not listed. S.A.E.

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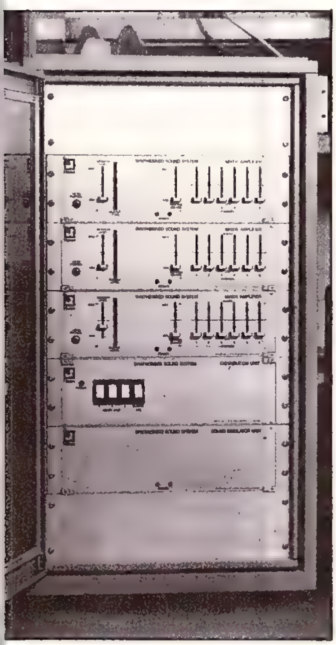
Telex 946708
E. & O.E.
Open to callers Monday-Friday 9 a.m.-5 p.m.

WW-11

CIRCLE 20 FOR FURTHER DETAILS.



ANY SOUND SYNTHESIZER

Up to eighteen different sound nvelopes may be stored in the ynthesizer/amplifier unit from Haven Automation. These may e selected and mixed to emulate ny combination of sounds 'from irdsong to double bass'. The ynthesizer was originally eveloped to reproduce the omplex sound spectra of a ship's ngine room to make training xercises more realistic. The ompany is now exploring arkets in the electronic nhancement of musical nstruments, speech therapy, ehicle and aircraft simulations nd the generation of sound ffects.

The system fits into 19in racks nd includes a sound simulator, hree mixer/amplifiers and a istribution unit. Each circuit is dentical to the others except that he different sounds are retained n eproms. The units nterconnect and are controlled hrough a GPIB which is also sed to control a set of filters to roduce a required sound. Eighteen signals from the istribution unit are combined in he three mixer/amplifiers to give he desired mix and output level or a specific environment. Haven Automation Ltd, Cwmru ndustrial Estate, Gendros, Swansea SA5 5LQ.

EWW 207

SATELLITE WEATHER MAPS

The use of new circuitry and a study of users' requirements has enabled Feedback to produce a weather satellite system, the WSR513, at a fraction of the cost of similar systems. The basic version will receive the APT (automatic picture transmission) signals from orbiting satellites in the 136 to 138MHz band. The addition of extra modules and a parabolic dish antenna allows reception of S-band transmission from geosynchronous satellites in the 1690 to 1697MHz band.

The basic version is supplied with a helical omnidirectional antenna which incorporates a single-stage preamplifier. This feeds a tuneable v.h.f. receiver and the a.m. subcarrier from this is output to a decoder which converts it to digital form which is entered into the internal memory and provides a synchronizing signal. The memory is continuously scanned by the raster timing generator, and images are converted back to analogue signals and displayed on the screen.

Front panel control allows the selection of resolution and format and local or satellite time for scan resolution and this can retain or remove the Doppler effect caused by satellite motion. The version to receive S-band transmissions includes a low-noise preamplifier in the dish antenna. The signal from this goes through an r.f. switch which is used to select S-band or APT transmissions. Controls include channel selection, automatic scan synchronization, semi-automatic picture acquisition and the selection of a specific part of the image for storage in the memory. Apart from its obvious uses in weather prediction, the system may be used as a teaching aid in geography and in the study of the technical and engineering aspects. Each equipment is supplied with a comprehensive installation and operation manual as well as information on satellites and the prediction of orbits. Feedback Instruments Ltd, Park Road, Crowborough, East Sussex TN6 2QR.

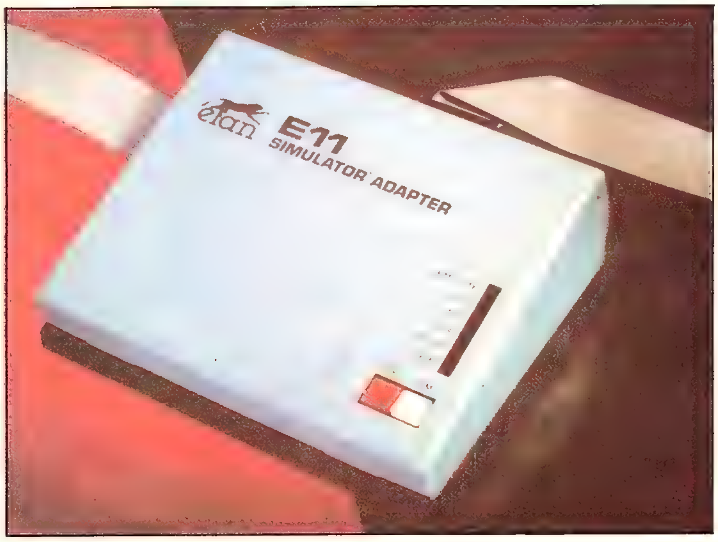
EWW 205

EPROM EMULATOR

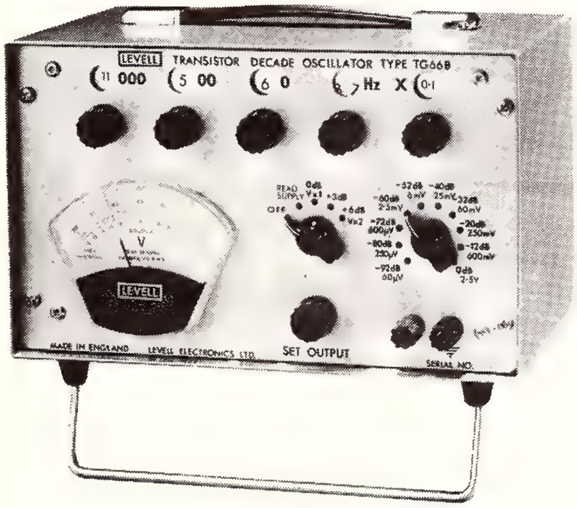
For use in conjunction with their E series of editing eprom programmers, Elan have introduced the E11 eprom simulator which can speed up program and hardware development by simulating a target eprom. Programs may be run, checked and easily altered before being committed to permanency in a eprom. One E11 may be used to simulate any of the current range of 24 and 28-pin devices including 2716, 2732, 2764, 27128 and 27256. Two units in a master/slave configuration may be used to provide twin eprom simulation or 16-bit simulation. The E11 is available in two versions; one up to 16K of memory (27128), the other up to 32K (27256).

Data is entered into the main programmer which is connected to the E11, the target eprom and to the microprocessor control system. The E11 has an access time typically of 175ns. Once programmed, the system may also be used connected directly to a microprocessor unit where it will function as a pseudo-eprom. Elan Digital Systems Ltd, 16 to 20 Kelvin Way, Crawley, West Sussex RH10 2TS.

EWW 206



DECADE OSCILLATOR


LEVELL TRANSISTOR DECADE OSCILLATOR TYPE TG66B
LEVELL
SET OUTPUT
MADE IN ENGLAND LEVELL ELECTRONICS LTD
SERIAL NO.

LEVELL ELECTRONICS have a range of oscillators covering frequencies from 0·02 Hz to 2 MHz.
There is a **FUNCTION GENERATOR** that provides sine, square, triangular, pulse and ramp waveforms with high output levels over a wide range.
Low distortion **RC OSCILLATORS** are available with analogue tuning and sine and square wave outputs.
The digital tuned series are as detailed below:

FREQUENCY	0·2 Hz to 1·22 MHz on four decade controls.
ACCURACY	±0·02 Hz below 6 Hz. ±0·3% from 6 Hz to 100 kHz. ±1% from 100 kHz to 300 kHz. ±3% above 300 kHz.
SINE OUTPUT	5 V rms down to 30 μV with Rs = 600 Ω.
DISTORTION	<0·15% from 15 Hz to 15 kHz. <0·5% at 1·5 Hz to 150 kHz.
METER SCALES	2 Expanded voltage and −2/+4 dBm.
SIZE & WEIGHT	260 × 180 × 180 mm. 5·4 kg.
TG66B	**TG66A**
Battery model **£295**	Mains & battery model **£310**

Prices exclude VAT. Free delivery in the UK. QUANTITY DISCOUNTS available. We supply many other instruments including:
FUNCTION GENERATORS, COUNTERS, OSCILLOSCOPES, dB & MICROVOLTMETERS.

LEVELL ELECTRONICS LTD.
Moxon Street, Barnet, Herts. EN5 5SD, England.
Telephone: 01-440 8686/449 5028.

CIRCLE 8 FOR FURTHER DETAILS.

The Archer-Single Board Computer

The ARCHER — a new Z80 based single board computer for professional applications. After a power failure, it carries on where it left off and the on board watchdog guards against software crashes.

SDS ARCHER single board computer	£150
SDS DEBUG ROM	£20
SDS BASIC ROM	£30
SDS ARCHER, CASED with on/off switch, mains connector, lead etc.	£200

OEM and distributor discounts available

FEATURES
- ★ 4 MHz. Z80A
- ★ 2 serial ports
- ★ Counter-timer chip
- ★ CMOS battery back-up
- ★ Bus expansion connector
- ★ On-board mains power supply
- ★ 4 Parallel ports with handshaking
- ★ 4 Bytewide memory sockets — up to 64k
- ★ Power-fail and watchdog timer circuits
- ★ High quality double sided plated through PCB

Sherwood Data Systems Ltd
Sherwood House
The Avenue
Farnham Common
Slough SL2 3JX

Sherwood Data Systems Ltd

Tel. 02814-5067

CIRCLE 76 FOR FURTHER DETAILS.

Appointments

Advertisments accepted up to 12 noon Tuesday, July 31st for August/Sept. issue
subject to space available.

DISPLAYED APPOINTMENTS VACANT: £17 per single col. centimetre (min. 3cm).
LINE advertisments (run on): £3.50 per line, minimum £25 (prepayable).
BOX NUMBERS: £5 extra. (Replies should be addressed to the Box Number in the advertisement, c/o Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS).
PHONE: LUCY O'SULLIVAN, 01 661 3033 (DIRECT LINE)

Cheques and Postal Orders payable to BUSINESS PRESS INTERNATIONAL LTD. and crossed.

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★ **Where does your interest lie:** Graphics; Comms; Robotics; Simulation; Image and Signal Processing; Medical; Automation; Avionics; Sonar; Acoustics; Weapons; Radar; Opto and Laser?

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★ **For free professional guidance:** Call 076 384 676 (till 8pm most evenings) or send your C.V. (no stamp needed) to:

ELECTRONIC COMPUTER AND MANAGEMENT APPOINTMENTS LIMITED
Freepost, Barkway, Royston, Herts SG8 8BR

1926

MICROPROCESSORS IN SOUND RECORDING

We make a range of timing and control products in the professional audio and broadcasting field and have a vacancy for an engineer to be in charge of production and test. The successful applicant would have experience in digital and microprocesor circuits (we use 6802), formal qualifications are important but not essential, an interest in sound recording would be an advantage. A certain amount of field work would be involved, so a driving licence would be required. A small expanding company such as ours is greatly in need of a bright and intelligent person will not only fill this post but also become involved in all parts of the company.

Salary in the range of £8,000 — £10,000.

Apply in writing to:
STEPHEN BROWN APPLIED MICROSYSTEMS LIMITED,
TOWN MILL, BAGSHOT ROAD, CHOBHAM, WOKING, SURREY.

(2625)

RADAR/RADIO ENGINEER

SALARY: Scale 3/4 up to £8,700 approx p.a. including shift pay and weekend allowances.

HOURS: 37 hr. wk. including Saturday and Sunday (no night duties).

QUALIFICATIONS: CITY AND GUILDS FULL (TT4)—TECH/ONC or equivalent, + a clean driving licence.

DUTIES: Repair and maintenace of airport 10cm. & 3cm. ground radars. Navigational aids including ILS and Communications equipment.

Applicants should have considerable experience and be capable of working without close supervision. Fault finding to component level is essential. Application forms are available from:
Airport Director, Southend Airport, Essex, SS2 6YF. Tel. no. (0702) 40201 ***Complete applications to be returned by Friday 6th July 1984***

(2639)

BROADCASTING ENGINEER LATIN AMERICA

To work as a technical advisor with a Latinamerican organisation for education by radio, with 40 affiliated radio stations in 17 countries.
The engineer will initially be based in Quito, Ecuador and will later travel to radio stations in other countries. The job consists of planning and running training courses for local technicians in the maintenance of studio equipment and mainly small short and medium wave transmitters and aerials.
Applicants should be familiar with the operation and repair of studio equipment and small transmitters and must be able to advise and instruct people with non-technical backgrounds in these skills.
The post is initially for three years on a basic salary. Because of extensive travel, it is unlikely to suit applicants with families. CIIR provides Spanish language training, pre-departure orientation (including instruction in teacing methods), insurance, air fares and various allowances.

For a job description and application form, please send a brief c.v. to CIIR Overseas Programme, 22 Coleman Fields, London N1 7AF, quoting ref. WW1.

The Catholic Institute for International Relations operates a secular overseas programme and is a member of the British Volunteer Programme. (2614)

ELECTRONICS TECHNICIAN

required for expanding South London company in the amusement industry.

Applicants are expected to have the appropriate qualifications (minimum HNC) and have experience of electronic engineering.
The work is interesting and varied, involving repairs, fault-finding and some research and development.

Salary scale is currently £8,400-£9,000 per annum.

Applications giving full details of age, qualifications and experience. (2615)

Appointments

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If you have HNC/TEC or higher qualifications and are looking for a job in design, test, customer service, technical sales or similar fields:

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We have vacancies in all areas of the UK
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(24 hours)

CAPITAL APPOINTMENTS LTD
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2450

MEDICAL PHYSICS TECHNICAL OFFICER

Medical Electronics
Saudi Arabia
c. £14,950 p.a. inc. tax free

Allied Medical Group are the British health care consultants to the prestigious 650 bed Riyadh Al-Kharj health care programme in Saudi Arabia. The two hospitals which comprise the Programme are new, superbly equipped, mainly U.K. staffed and enjoy a full range of paramedical and support services.

The Bio-Engineering Section of the Department of Medical Physics and Bio-Engineering — based in Riyadh — is responsible for servicing approximately 2,200 items from a wide range of bio-medical equipment.

We now need an MPTO to specialise in the maintenance of an extensive range of laboratory equipment covering clinical chemistry, haematology, microbiology and histopathology. The complexity of the equipment ranges from multi-channel analysers and centrifugal analysers to simple tissue processors and centrifuges. You will work with two other technicians repairing and scheduling maintenance of the laboratory equipment. This small group also provides a maintenance service to the Medical Physics Department's Nuclear Medicine, Radiation Protection and Radiotherapy Sections for their nucleonic counting equipment.

For this post, you will need an HNC or equivalent plus at least four years experience.

The Sterling salary quoted (based on 5.0 Saudi Riyals = £1) includes a bonus of one month's salary for each twelve months satisfactory service, payable at the end of contract.

In addition to the tax free salary, this two year single status contract post attracts one of the best benefits packages offered in the Middle East.

For further details and an application form, please write quoting Ref: P/RKH/6653/WW, to: Kate Vincent, Personnel Officer, Allied Medical Group, 12/18 Grosvenor Gardens, London, SW1W 0DZ. Alternatively, call our 24 hour answering service on 01-730 5339, quoting reference number.

All applications will be dealt with in the strictest confidence.

Allied Medical Group
The Best of British Health Care in the Middle East

(2632)

TEST EQUIPMENT DESIGN ENGINEERS

Rediffusion Consumer Manufacturing design and manufacture a full range of advanced specification colour television receivers and monitors.

We are looking for experienced Electronic Design Engineers to help us maintain our industry lead in sophisticated computer controlled test gear for production testing of our products. Future test equipment will be an interesting mix of digital and analogue circuitry aimed at increasing the automation of the production testing operation.

If you are able to conceive, design and implement production test equipment with minimal supervision, we'd like to hear from you.

These positions are based in our Chessington Engineering Centre but some visits to our factories in the North East and Lancashire will be required at infrequent intervals. Salaries are obviously dependent on qualifications and experience, but will reflect the importance of future test gear projects to the Company's long term development.

Interested ? ... Then write or phone:

Harry Brearley,
Rediffusion Consumer Manufacturing Ltd.,
Fullers Way South,
Chessington, Surrey. KT9 1HJ.
Telephone: 01-397-5411.

REDIFFUSION

(2408)

ELECTRONIC INSTRUMENT FIELD SERVICE TECHNICIANS

Sartorius Instruments is a world leader in electronic weighing in the analytical, research, quality assurance and allied industries. The product range is expanding further into industry and personnel are required to supplement our already established Field Service team. Areas with a vacancy include the South Midlands and Northern home counties plus a relief engineer prepared to travel nationwide.

Successful applicants will service and install our electronic weighing instrument systems. Primary responsibilities will be problem solving of Sartorius equipment contract maintenance and customer liason.

Education to a suitable allied qualification ie. C & G/TEC – Electronics is preferred for the relief engineer. A successful trouble shooting ability in electronics experience of balance/scale service or maintenace of fine instruments is otherwise necessary. On appointment you will spend 4 weeks training in our workshop in Belmont.

Candidates must be in possession of a current driving licence and over 23 years of age. A company car is provided.

In additional to the above vacancies trainees are required for general electronic and mechanical balance maintenance at our in-house service centre at Belmont – Surrey.

If you would like to apply for a position
Please write for an application form to the
Service Co-Ordinator
Saratorius Instruments Ltd
18 Avenue Road Belmont Surrey
Telephone No. 01-643 8870

(2621)

EARLY RESPONSIBILITY IN ELECTRONICS

Are you recently qualified (HNC — H.TECH or DEGREE) with hands-on sandwich or work experience in both analogue and digital circuitry and electronic test knowledge and with the ability to programme in 'Basic'?
Then if you have the initiative to take responsibility for the design, construction and maintenance of specialised and proprietary test equipment, contact us by telephone and we will send you a form, or write to us with full c.v. and an indication of your salary requirements.

Telephone CHERTSEY 62671
Personnel Department

Kent Industrial Measurement Limited

Hanworth Lane, Chertsey, Surrey.

(2608)

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Clip this advert and you can stop hunting for your next appointment. We have a wide selection of the best appointments in Digital, Analogue, RF, Microwave, Microprocessor, Computer, Data Comms and Medical Electronics and we're here to serve *your* interests.

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(1935)

THE EUROPEAN MOLECULAR BIOLOGY LABORATORY
A Research Institute Situated in Heidleberg, West Germany, INVITES APPLICATIONS FOR THE FOLLOWING POST:

SYSTEMS INTEGRATOR

The successful candidate will be responsible for the conception and implementation of Microcomputer Hardware and Software for use in various projects with the Laboratory such as on-line Image Processing and Graphic Display Systems.

Systems already in use in the laboratory are based on Z80 and M68000 processors in the VME standard configuration. A knowledge of these systems is desirable but not essential.

The basic salary offered will be around DM3900 — monthly. Certain allowances will be payable in addition, depending on personal circumstances. An initial contract of 3 years will be offered, which can be renewed.

PLEASE WRITE BRIEFLY FOR AN APPLICATION FORM, QUOTING REFERENCE N.83/23 TO:

EMBL, PERSONNEL SECTION,
POSTFACH 10.2209, D-6900 HEIDELBERG

(2617)

Electronics Engineers £9561

Communications Design in High Tech Country

At H.M. Government Communications Centre we're using the very latest ideas in electronics technology to design and develop sophisticated communications systems and installations for special Government needs at home and overseas.

With full technical support facilities on hand, it's an environment where you can see your ideas progress from initial concepts through prototype construction, tests and evaluation, to the pre-production phase, with a chance to influence every stage. Working conditions are pleasant, the surroundings are attractive, and the career prospects are excellent.

Ideally we're looking for men and women who have studied electronics to degree level or equivalent and have had some experience of design, whether obtained at work or through hobby activities. Appointments will be made as Higher Scientific Officer (£7149-£9561) or Scientific Officer (£5682-£7765) according to qualifications and experience.

For further details please write to the address given below. As our careful selection process takes some time, it would be particularly helpful if you could detail your qualifications, your personal fields of interest and practical experience, and describe the type of of working environment most suited to your career plans.

The Recruitment Officer, HMGCC, Hanslope Park, Buckinghamshire MK19 7BH.

(2448)

Senior Wireless Engineer

telecommunications training
of vital national importance

This is an opportunity to join a team which provides vocational training for technical staff in the operation and maintenance of telecommunication equipment for Police Forces and Fire Brigades in England and Wales and for the Home Defence and Prison Services.

You will identify staff training requirements, develop new training techniques, approve applications for academic training, operate to a financial budget, prepare estimates, provide statistical reports and cost data on Directorate of Telecommunications training and serve as Training Liaison Officer.

Candidates should have an appropriate degree or equivalent (including overseas) qualification in electronics **or** be suitably qualified senior technicians who have appropriate training and about 15 years experience in a related field of work and who have either satisfied the CEI requirements for registration as a Technician Engineer or hold an HNC/FTC in Electronics or Telecommunications. Applicants should, preferably be corporate members of a relevant professional institution. All candidates should have at least 4 years experience in the design, installation and maintenance of communication systems, preferably in the field of mobile radio and be capable of the day-to-day supervision of a small section of technical instructors and administrative staff. The post requires an officer with a good knowledge of telecommunication practice and principles, including micro-electronics, and the capability of preparing and presenting courses which are essentially orientated towards the maintenance of telecommunication equipment coming into service because of the World Administrative Radio Conference (WARC) Frequency Conversion Programme.

Salary for this Stanmore-based post will be within the range £10,575-£12,660 (including £500 Outer London Weighting) according to qualifications and experience. SALARIES UNDER REVIEW.

RELOCATION ASSISTANCE MAY BE AVAILABLE.

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The Civil Service is an equal opportunity employer

Home Office

(2638)

BORED ?

Then change your job!

1) Electronics Test Engineer
£8,500 Z80 and instrumentation and calibration. Herts area.

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£8,500. Hand held radio and allied communications equipment. Advanced field. Croydon.

3) Technical Support Engineer
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4) Test Engineer.
Test and troubleshoot minis and micros. Berks area.

Service Engineer.
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Hundreds of other Electronic and Computer vacancies to £12,500

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Roger Howard, C.Eng., M.I.E.E., M.I.E.R.E.

CLIVEDEN CONSULTANTS
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Tel: 0344 489489

(1640)

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U.K. & Export

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- TECHNICAL SUPPORT ENGINEERS
- AREA SALES MANAGERS
- REGIONAL SALES MANAGERS

We are Racal – Dana Instruments Ltd., an international manufacturer of sophisticated electronic test and measurement instrumentation for the radio communications, ATE and microprocessor based industries.

We are looking for men or women educated to at least HNC level in electronics who have a solid basis of practical experience. Knowledge of the radio communications industry would be advantageous and for overseas sales a second language (French or Spanish) would be useful.

If you are ambitious and are seeking a new challenge these opportunities will allow you to develop your career in selling high technology products and will open up exceptional promotional paths in several different areas.

We can also offer an attractive salary package including company car for U.K. direct sales staff, over five weeks annual leave, staff pension and free life assurance scheme plus many other benefits associated with a major employer.

If you are interested please telephone Graham Addison to find out further details on Windsor (07535) 68101. Or write giving full details of career and current salary to:- Personnel Officer Racal – Dana Instruments Ltd., Duke Street, Windsor, Berkshire.

RACAL

(2631)

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HIGH TECHNOLOGY / ATE EQUIPMENT

S. ENGLAND

to £16K

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This is a first class career opportunity for a person with knowledge and experience of Hi-Tech. Electronic and Automatic Test Equipment Development. Your technical interest will be immediately captured by the highly advanced technology now being employed. Your challenge will be to integrate the product with the design of the ATE, providing innovative solutions to both design and test methodology problems.

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To support the growth of the above mentioned engineering division our client also has **vacancies for Engineers in less Senior positions**

These important positions present a major opportunity to the professional engineer set to establish a career in Hi-Tech Electronic and Automatic Test Equipment Design and Development. Our client provides an attractive salary package, the possibility of travel and full company benefits, including five weeks holiday and a generous relocation package to an attractive location in S. England.

To find out more and to attain an early interview please contact **KEN JACOBSEN** in complete confidence on Hemel Hempstead (0442) 47311 during office hours or one of our duty consultants on Hemel Hempstead (0442) 212650 evenings or weekends. Alternatively write to him at the address below.

Executive Recruitment Services

THE INTERNATIONAL SPECIALISTS IN RECRUITMENT FOR THE ELECTRONICS COMPUTING AND DEFENCE INDUSTRIES

25-33 Bridge Street, Hemel Hempstead, Herts., HP1 1EG.

(2634)

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Applications are invited for immediate and forthcoming bachelor status vacancies with our Company in the Sultanate of Oman. The work involves the maintenance of modern military equipment associated with the three branches of the Armed Services.

Ideally, applicants should have a thorough knowledge of techniques and have been employed for a minimum of 5 years' within the field of one or more of the following: mobile and static military radio systems, associated antennae and ancillary equipment; cryptographic and telegraphy equipment: weapons fire control systems and navigation aids used in air traffic control.

If you feel you are suitably qualified and interested in joining our Company, please write giving a brief summary of your qualifications and experience to: **The Company Personnel Manager, Airwork Limited, Bournemouth-Hurn Airport, Christchurch, Dorset BH23 6EB.**

(2640)

Airwork Limited

1983

UNIVERSITY OF OXFORD

Dyson Perrins Laboratory

R.F. Electronics Engineer

An electronics engineer with qualifications to degree or H.N.C., standards is required to develop radio frequency accessories associated with Nuclear Magnetic Resonance instruments, working at up to 500 MHz. The ability to contribute to software developments connected with the same instruments will be of added value. Appropriate experience demonstrating the ability to progress the hardware developments unassisted will be expected. Nuclear Magnetic Resonance is an important and growing scientific and medical technique and this two year appointment offers an opportunity to gain valuable experience in this area.

The appointment will be at up to £8530 p.a., depending on experience. Further particulars from and written applications with the names of two referees to:

Dr. A.E. Derome,
Dyson Perrins Laboratory,
South Parks Road, Oxford. OX1 3QY
Tel. Oxford 59601, ext. 203.

(2633)

Electronics Technician

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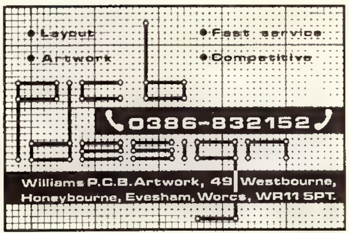

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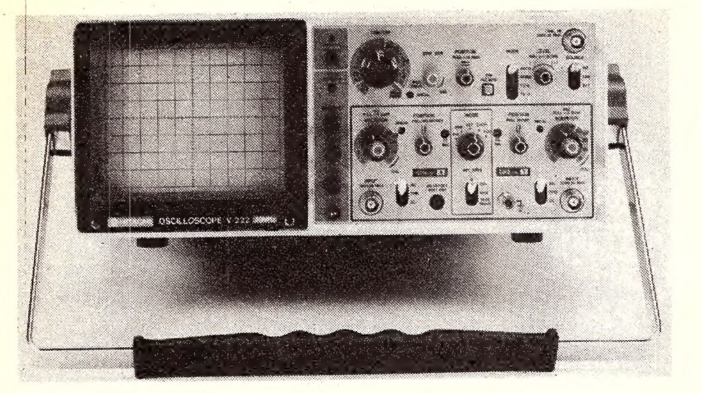

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ELECTRONICS & Wireless world

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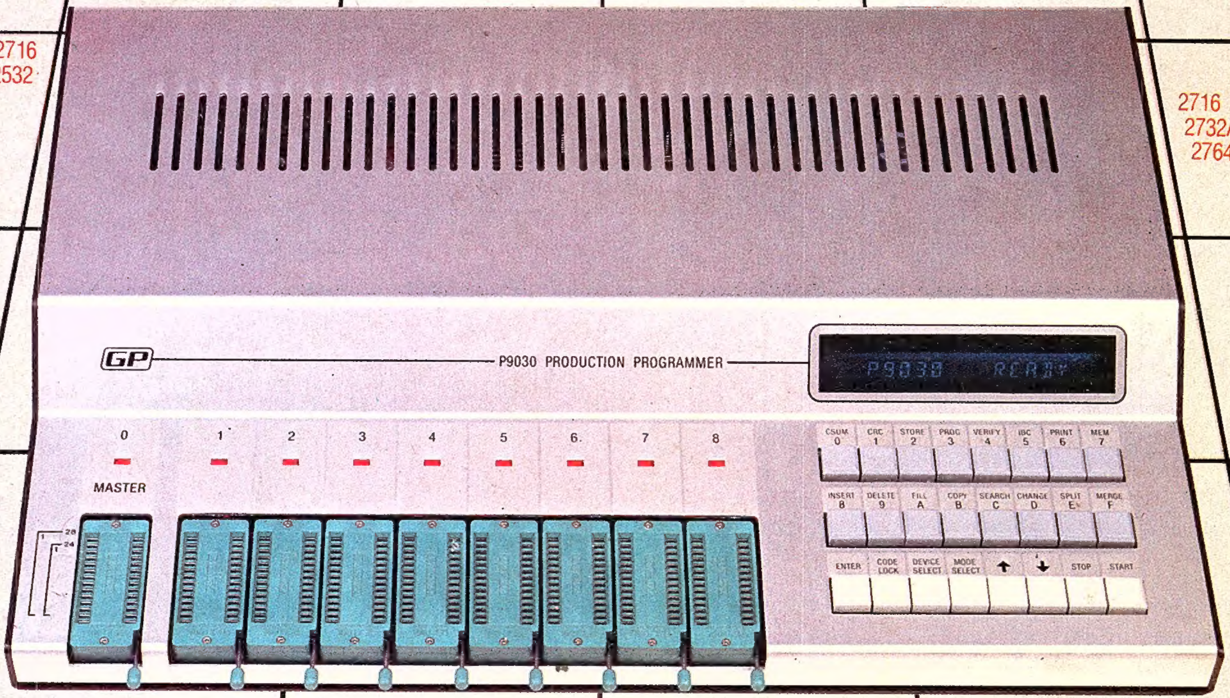
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